THE EFFECTIVENESS OF CERTAIN CHLORINATED HYDROCARBONS AS TOXICANTS IN BAITS AND SPRAYS FOR THE CONTROL OF GRASSHOPPERS IN KANSAS

by

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INTRODUCTION

Kansas has been called the "Grasshopper State" for many years even though other states have consistently more grasshoppers. Dean and Kelly (1920) believed that Kansas should not be called the "Grasshopper State" because of the widespread damage caused by the grasshopper in other states. The grasshopper problem is more acute in Kansas because a great portion of land is planted in crops.

Because of the acute grasshopper problem in Kansas, early attempts at its control were carried out in this state. One of the most significant advances in grasshopper control originated in Kansas in the early 1900's. This event was the introduction of a grasshopper poison called the Kansas bait. This mixture consisted of bran, a toxicant such as white arsenic, London purple or Paris green, a sweetener such as syrup or molasses, and an attractant such as oranges or lemons and water.

In 1917, it was demonstrated in Kansas that grasshoppers could be controlled on a large scale by the use of the Kansas bait. Furthermore, the organization of large scale grasshopper poisoning campaigns in various counties in Kansas proved so effective that the farmers accepted the Kansas bait readily.

The Kansas bait, however, was not the panacea for grasshopper control. Its kill was not always dependable because of factors such as temperature, type of vegetation in the treated area, etc. However, the Kansas bait remained the best grasshopper control measure for many years.

Further work proved sawdust could be mixed with the bran in poison baits with no subsequent reduction of its attractiveness to the grasshoppers. The addition of sawdust in the bran bait formula extended the supply of available bran and was more economical. Likewise, fruit and molasses were eliminated when it was found that they did not appreciably add to the attractiveness of the bait formula.

Because of the sporadic success of the poison bran baits against the grasshopper, there was considerable work done in search for better control methods. Dusting various toxicants on vegetation proved unsuccessful, as did spraying with sodium arsenite. Meanwhile, the Kansas bait continued to be the standard recommendation.

During World War II, entomologists in the Bureau of Entomology and Plant Quarantine, searching for new insecticides to control insects that affected our food reserve and the health of our fighting men, learned that a Swiss chemist had prepared a chlorinated hydrocarbon, DDT, which proved to be very toxic to insects. As a result, it received much publicity and acclaim, and soon became widely used.

The economic entomologists tested samples of DDT as sprays against grasshoppers, but the results were not spectacular. Other chlorinated hydrocarbons followed DDT, of which chlordane and toxaphene proved very successful in grasshopper control on succulent foliage.

This experiment was chosen because:

1. There has been no investigations on the use of aldrin,

chlordane, or toxaphene in baits in Kansas.

2. Additional experiments on the effectiveness of some of the newer chlorinated hydrocarbons when used as sprays against grasshoppers in eastern Kansas were desirable.

3. It seemed desirable to note the effects of temperature and time of application on the effectiveness of the chlorinated hydrocarbon baits against the grasshoppers.

Some of the objectives of this work were:

1. To study the effectiveness of certain chlorinated hydrocarbons as toxicants in baits.

2. To substitute some of the newer insecticides used as sprays in baits against the grasshoppers, Melanoplus mexicanus and M. bivittatus.

3. To attempt the control of the grasshopper in alfalfa by means of chlorinated hydrocarbon sprays and to note any obvious effects of these materials against other insects.

The work was undertaken as a part of the Kansas Agricultural Experiment Station Projects, Bankhead-Jones 211 and Commercial No. 56.

REVIEW OF LITERATURE

Since early times, the grasshopper or locust has been the bane of mankind. In Biblical times there are descriptions of times when locusts ate all the herbs of the land and all the fruit on the ground, causing great famines. References to this are found in Psalms cv:34-35 and Exodus 11:14-15.

Ancient China too had its locust problem which was so in-

tense that the army as well as the populace fought them. Scatchkow (1883) refers to an early attempt by the people to control this menace. He asserts that the ancient Chinese believed that at sunrise locusts, upon creeping up the long stems of corn and other strong grasses and sipping dew until they could neither fly nor jump, could be driven easily into containers and from them burned by fire or scalded by hot water.

Along with the destruction of adult and nymphal stages of the locust, much emphasis was placed on the destruction of eggs as a means of control. In Europe, entire villages turned out to dig locust eggs. Our neighbor, Missouri, has paid as much as 50 cents for each bushel of grasshopper eggs gathered (Rept. U. S. Ent. Comm., 1878). Several other states, including Kansas, have also paid bounties for grasshopper eggs.

The destruction of locust eggs by a chemical was reported by Mochuskit (1858). This was accomplished by watering heavy egg beds with a solution of water and lye.

The United States Entomological Commission in 1878 stated, "We have never had much faith in the application to any plant or insect of any chemical mixtures, fluids, powders as means of destroying grasshoppers."

LeConte (1876) foresaw some sort of spraying apparatus with several nozzles connected to large tanks of fluid and powered by steam, horse, or man power. It is known that this type of apparatus was eventually used for grasshopper control, but its first and main use until comparatively recently has been the spraying of orchards.

Criddle, according to Gibson (1915), in 1901 upon noticing that grasshoppers feeding upon lush vegetation in a field and leaving this succulent food to feast on fresh horse droppings, devised an early poison bait by adding some poison such as white arsenic or Paris green to horse manure.

Horse manure as a bait constituent was soon dropped, but the bait idea had proved to be the most practical and efficient control for grasshoppers at that time. Milliken (1916) recommended a mixture of white arsenic or Paris green and wheat bran to be mixed with water and placed in small piles or balls around the areas of the field where the grasshoppers were doing the most damage. This pile or ball method of making the bait available to grasshoppers was abandoned when it was found that birds, poultry, or other domestic animals were poisoned by the bait. Instead, the bait was broadcast in order to minimize the danger to animal life. The quantities of ingredients in the poison bait referred to by Milliken (1911), known as the "Kansas mixture," were as follows for five to ten acres:

Bran	20 lb.
Paris green or white arsenic	1 lb.
Syrup	½ gal.
Lemons or oranges	3 gal.
Water	3½ gal.

The above formula, with white arsenic or sodium fluosilicate as the toxic agent, has been the recommended chemical control for grasshoppers until the development of the chlorinated hydrocarbons. The only modifications have been in the substitution of

sawdust for some of the bran and the elimination of the fruits and syrup.

There were several experiments with the use of sodium arsenite spray for grasshopper control, but the results in Kansas were not satisfactory.

During World War II, considerable publicity was accorded the use of one of the chlorinated hydrocarbons, DDT, because of its phenomenal success in the destruction of insects. In the years immediately following the war, much work was done on the development of other chlorinated hydrocarbons as insecticides. Kearns (1945), Brett and Rhoades (1947), and Weinman and Decker (1947) found that some of the newer chlorinated hydrocarbons were effective against grasshoppers. Weinman and Decker (1949) reported that insecticidal sprays for grasshopper control are not only practical but give much more satisfactory results than poison baits in Illinois. They also state that sprays are superior to dust both in initial kill and in the persistence of effectiveness.

Parker and Wakeland (1948, 1949, 1950) stated that on dense succulent vegetation two chlorinated hydrocarbons, chlordane and toxaphene, are very effective when applied as sprays. Under these conditions the results initially are better and they continue to kill longer than the formerly popular sodium fluosilicate bait. These workers later state that, in sparse short green vegetation and grain stubble, baits are as effective as sprays and more economical.

Butcher, Wilbur, and Dahm (1950) working in Kansas indicated that four of the chlorinated hydrocarbons--chlordane, toxaphene,

parathion, and aldrin--killed grasshoppers better and over a longer period of time than did the standard sodium fluosilicate wet-bait.

MATERIALS

Experimental Plots

Four miles east of Manhattan, Kansas on Highway U. S. 24-40, at the ManKan Airport, a large population of grasshoppers was discovered in newly-cut alfalfa. These grasshoppers were predominately Melanoplus mexicanus DeG. The west portion of the ManKan Airport, Plate I, was divided into 16 plots of 2.5 acres each. Two adjacent fields were located south of Manhattan in Geary County on R.F.D. 2 at the farm of A. E. Hickman. The alfalfa in these fields was not able to grow because of a heavy population of M. bivittatus Say.

The alfalfa fields in Geary County were very irregular in shape and comprised approximately 10 acres. Because these fields were so remote, no marking of the plots was done.

Insecticides

Toxicants Used in Sprays. The toxicants used were toxaphene, aldrin, and chlordane. The toxaphene was Coopertox 65 per cent emulsifiable concentrate obtained from the Wm. Cooper & Nephews Inc., chlordane was 74 per cent emulsifiable concentrate obtained from the Julius Hyman Co., and the aldrin was an experimental quantity of 25 per cent emulsifiable concentrate which was obtained

EXPLANATION OF PLATE I

West portion, ManKan Airport, divided into plots of 2.5 acres. The plots, designated by numbers or letters, and the material applied to them are shown below.

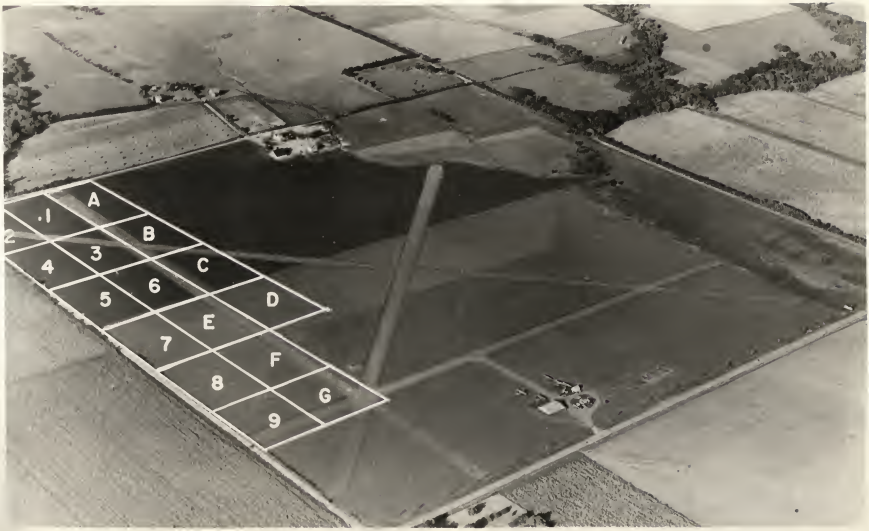
Sprayed Plots

A. Chlordane
B. Toxaphene
C. Aldrin
D. Toxaphene
E. Aldrin
F. Chlordane
G. Check

Baited plots

1. Toxaphene
2. Chlordane
3. White arsenic
4. Aldrin
5. Toxaphene
6. Check
7. Chlordane
8. Aldrin
9. White arsenic

PLATE I



from the Julius Hyman Co.

The materials used, their formulation, and the amount of actual insecticide used per acre of alfalfa at the ManKan Airport for the control of grasshoppers are shown in Table 1.

Table 1. The materials used in sprays, pounds of actual insecticide per acre of alfalfa, and their formulation, at the ManKan Airport for the control of grasshoppers.

Material	Pounds of actual insecticide per acre	Formulation
Toxaphene	1.76	65% emulsifiable concentrate, containing 6.8 lbs. of toxaphene per gallon.
Chlordane	1.0	74% emulsifiable concentrate, containing 8 lbs. of chlordane per gallon.
Aldrin	0.25	25% emulsifiable concentrate, containing 2 lbs. of aldrin per gallon.

Toxicants Used in Baits. The toxicants used in baits were chlordane, 74 per cent emulsifiable concentrate containing 8 pounds of technical material to the gallon at the rate of 0.05 pounds of technical material per acre of alfalfa; toxaphene, 65 per cent emulsifiable concentrate containing 6.8 pounds of technical material to the gallon at the rate of 0.1 pounds of technical material per acre; aldrin, 25 per cent emulsifiable concentrate containing 2 pounds of technical material to the gallon at the rate of 0.0124 pounds of technical material per acre; and white arsenic powder, 6.4 ounces per acre.

Mixing the Baits. The baits were composed of bran, a toxicant, and approximately 3 gallons of water or enough water to properly wet the bran. The insecticides, toxaphene, chlordane, and aldrin, were added to water and sprayed from a three-gallon, hand, air-compressed sprayer to their respective 25 pounds of bran that was spread on a concrete slab. The white arsenic was dusted uniformly over the bran that was spread on the concrete slab and dry-mixed thoroughly with the bran before the water was added. A shovel was used for the mixing of these materials.

Bait Formula. The formula for each portion of the poison bait consisted of the following ingredients which were used on one acre:

Bran	10 lb.
Insecticides, either	
Toxaphene*	0.1 lb.
Chlordane*	0.05 lb.
Aldrin*	0.0124 lb.
White arsenic	.40 lb.
Water	1-2 gal.

*Actual insecticide.

Spray Equipment

The sprays were applied with a John Bean model 4-E two-wheeled sprayer, with a spray boom 16 feet in length, containing 13 nozzles, producing a fan-shaped spray and operating at 30 pounds pressure per square inch. Approximately 12 gallons of solu-

tion were sprayed per acre while the sprayer was pulled by an automobile at the rate of three miles per hour.

METHODS

Evaluation of the Grasshopper Population

Separate adjacent plots of 2.5 acres were used in this experiment. Grasshopper counts were taken by sweeping the alfalfa plants with cloth sweeping nets which measured approximately 13 inches in diameter and from 20 to 28 inches deep. The counts were taken from three strips in each of the plots--the two outer strips were at least 60 feet inward from each side and end of the plot, while the center strip was mid-way between the two outer strips. Each strip was divided into five stations. From each station, 12 unit counts were taken which consisted of three sweeps per unit or 36 sweeps per station. This made a total of 180 sweeps per strip or 540 sweeps per plot. It was believed that this method of determining the relative grasshopper population was more accurate than attempting to estimate the numbers of grasshoppers per square yard.

Figure 1 shows the scheme of the sweeps made in the plots.

Counts were made immediately before treatment and were repeated at 24 hours, 72 hours, and 7 days after treatment.

Each of the plots used for the spraying and baiting tests had one replicate not immediately adjacent. Separate check plots were used for each of the spraying and baiting series.

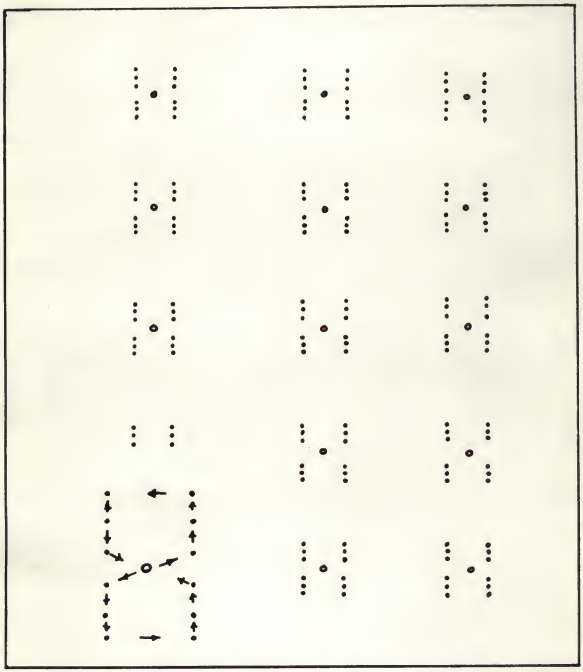


Fig. 1. Positions in a 2.5 acre plot to show where sweep net samples were made to evaluate the grasshopper population. Small circles in the center of the rows of dots indicate the starting point. Dots represent points from which three sweeps of the net were made. Enlarged section in lower left-hand corner indicates the direction taken by two persons with nets during the sweeping process.

Application of Baits

The baits for the tests at ManKan Airport were mixed the night before their application and placed in burlap bags overnight to assure that a good saturation of the toxic materials and water into the bran occurred. The poisoned bait was removed the following morning and taken to the field for application.

The bran bait was poured into a small wash tub which rested on the right front fender of a 1946 model Ford automobile. Since the baits were applied by hand, the person who applied them sat astride the front of the hood of this automobile with his feet resting on the front bumper. With his left hand he steadied himself as the automobile moved slowly through the field, and with his right hand the bait was broadcast.

The method of broadcasting the bran was as follows. The right hand was put into the tub containing the material and brought out again with as much of the material as it could hold. The hand containing the material was moved sharply to the left in a wide sweeping motion, and at the same time the relaxing of the thumb and the first finger occurred to release a stream of the bait. When the end of the sweep came, the right hand was reversed in the same sweeping motion, but this time the 3rd, 4th, and 5th fingers were relaxed to permit the bran to stream out. This was repeated throughout the field, and, as the car was traveling between two and three miles per hour, the broadcaster had ample time to see that the material was spread evenly throughout the field.

No flags or men were used to guide the driver of the automo-

bile because the cut alfalfa was thick enough to show the tracks of the automobile and to serve as a guide.

The plan of distributing the bait was as follows: As the bait was distributed, the automobile at approximately 12 feet from one side moved parallel to that side from one of the adjoining sides to the opposite side. When this side was reached, the bait broadcasting was stopped while the driver drove into the adjoining field to turn around. When the automobile returned to the field being treated, it began at a point approximately 24 feet from the first tracks in the alfalfa and moved toward the opposite side parallel to its initial tracks. This procedure was followed until a plot was baited completely.

Spraying

Calibration of Spraying Equipment. Before the actual spraying was begun, it was necessary to calibrate the spraying equipment so that a known amount of spray could be dispensed in a known area. The preliminary step in the calibration consisted of putting a small amount of water in the tank of the sprayer, starting the pump engine, and opening the valve that controlled the flow of the material from the tank, through the pump, and finally through the nozzles to the ground. This operation was necessary in order to see that all of the nozzles were open and that the liquid was being dispensed freely from them. For the actual calibration, the following formula obtained from Dr. Paul Dahm was used:

$$\frac{66 \times \text{gallons used in 40 rods}}{\text{width of the boom}} = \text{gallons sprayed per acre}$$

The sprayer tank was filled with water, and the sprayer was drawn by the automobile at a certain speed for 40 rods with the main valve open and the sprayer dispensing the water at a set pressure. At the end of 40 rods, the main valve was closed. In order to measure the number of gallons used in 40 rods, water carefully measured was added to the tank until the water sprayed during the 40 rods was replaced. This amount of water was substituted in the above formula and divided by the width of the boom. The resulting figure multiplied by 66 indicates the amount of water sprayed per acre by the sprayer, provided the pressure and rate of travel by the sprayer remained the same as when the test was run. If a higher or lower speed or an increase or reduction in pressure is desired, then a test run using the above formula must be performed again.

Application of Spray. In the spraying of a plot, the equipment and personnel consisted of a sprayer, an automobile to draw the sprayer, one driver for the automobile, and four men to act as guides for the driver. These guides were necessary to keep the sprayer in straight lines and to eliminate the possibility of missing strips or treating other strips more than once.

The procedure during the spraying operation was as follows:

The four guides took initial positions at points approximately 9 feet from the two sides of each of the four corners of a 2.5 acre plot. Although the boom of the sprayer measured 16 feet in length, the flat, fan-shaped spray from it covered an extra length of one foot on either end of the boom to make the total swath 18 feet wide. With the guides standing at 9 feet, which was exactly

one-half of the swath length, the driver of the automobile could drive directly from one guide to a distant guide on the same side of the plot and the sprayer would be on the line between the two guides, and a swath could be sprayed evenly along the outer 18 feet of the 2.5 acre plot. The automobile and the sprayer, which made up the spray rig, were put on an imaginary line between two guides at a point close to one of the guides on one side of the field. The motor of the sprayer was started, and the main valve of the sprayer was opened as the automobile began to move at three miles per hour toward the distant guide.

As the spray rig left the starting point, the guide who was at that point faced to his left and took four steps, which measured approximately nine feet, before he stopped. The second guide, referred to before as the distant guide, as soon as the spray rig had passed him, took four steps in the same direction as the spray rig had been going, stopped, faced to his left, took four more steps in the new direction, and stopped again. This same procedure was followed by the third and fourth guides. After the spray rig had passed the first guide again, this man followed it for four steps, stopped, faced to his left, took two additional steps, and stopped. The method of proceeding to new positions was repeated by every guide until the entire field was sprayed. Figure 2 shows the direction of travel by the spray rig through a plot being treated and the positions of the guides.

Formula for the Evaluation of Effectiveness of Insecticides

For the evaluation of the effectiveness of the insecticides

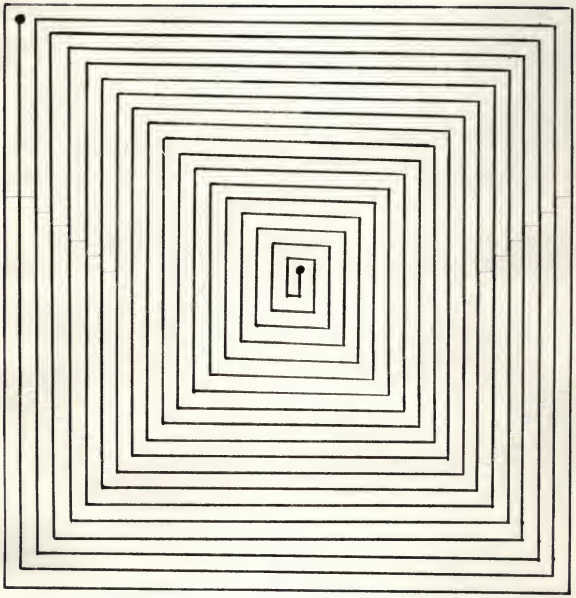


Fig. 2. Path taken by the spray rig during the spraying of a 2.5 acre alfalfa field at the Mankan Airport. Dot in upper left-hand corner indicates starting point, and dot in center indicates stopping point.

used as baits and sprays at the ManKan Airport, the following formula was used:

$$100 \times \frac{X-Y}{X} = \% \text{ Reduction}$$

Where X = No. insects living in the check plot.

Where Y = No. insects living in treated plot.

Evaluation of the Effectiveness of the Sprays in Reducing Webworm Damage

Thirteen days after spraying the materials toxaphene, chlordane, and aldrin on alfalfa, an infestation of the garden webworm, Loxostege similalis Guen, was noted throughout these plots. This insect pest defoliates the alfalfa plants, thus reducing the vigor and occasionally killing the stand.

In order to evaluate the degree of infestation in the six fields, each field was traversed by the observer following a diamond-shaped route. The observer starts from the center of one side of a field and walks to the center of an adjoining side; continues to the center of the side opposite from the starting point; and then back to the starting point. The observer inspected 50 alfalfa plants along this route at random and evaluated them numerically as follows:

0. No infestation.
1. Worms present but no injury noted.
2. Slight injury.
3. Somewhat more injury.

4. Severe injury.

5. Foliage destroyed.

EXPERIMENTAL RESULTS

Baiting - ManKan Airport

When poison bran grasshopper baits with the toxicants--toxaphene emulsifiable concentrate at 0.1 pounds per acre, chlordane emulsifiable concentrate at 0.05 pounds per acre, aldrin at 0.0124 pounds per acre, and white arsenic powder at 6.4 oz. per acre--were applied to the test plots, the following detailed results were secured. Tables 2 through 5 give the relative grasshopper abundance as determined by the sweep net method immediately before baiting, 24 hours after baiting, 72 hours after baiting, and 7 days after baiting.

Table 2. Grasshopper populations on baited plots immediately before treatment with four toxicants at the ManKan Airport as determined by the sweep net method.

Plot no.	Grasshoppers caught in net after 36 uniform sweeps for each station					Total
	Station 1	Station 2	Station 3	Station 4	Station 5	
			Toxaphene			
1	E. to W.					
	4 5 5 1 3 3	4 5 2 3 3 7	4 5 10 5 4 8	3 9 8 5 4 7	3 10 6 6 5 3	
	8 10 11 6 2 2	17 4 6 2 5 5	8 5 8 5 5 9	5 1 6 2 4 6	4 11 6 3 6 7	
	W. to E.					
	7 5 9 10 6 8	3 2 6 9 6 3	1 2 2 2 8 7	6 5 3 3 1 6	7 3 5 6 4 2	
	5 7 8 11 10 6	8 4 5 5 8 5	1 4 4 10 9 5	1 4 1 5 6 2	2 5 3 4 4 6	
	E. to W.					
	8 1 5 4 2 4	5 8 8 10 6 5	3 1 5 5 4 6	6 8 5 10 5 2	6 4 5 5 6 2	
	4 7 10 5 1 3	5 3 8 7 3 4	8 9 3 6 5 4	5 8 5 3 2 4	8 11 8 13 2 9	966
			Chlordane			
2	W. to E.					
	10 3 4 1 3 5	5 6 4 2 5 6	8 5 5 7 4 4	6 8 6 4 6 4	1 8 7 1 2 3	
	11 7 5 6 4 4	20 10 19 2 3 9	4 7 11 8 8 5	5 8 3 3 3 8	4 5 6 5 5 4	
	E. to W.					
	9 9 8 13 12 9	7 11 8 14 7 1	4 1 4 7 2 3	4 3 3 5 1 0	1 2 1 9 6 7	
	8 6 5 10 1 5	12 7 5 4 3 3	1 3 0 3 6 5	2 1 1 3 2 5	4 3 7 5 3 8	
	W. to E.					
	8 8 5 6 4 3	5 1 1 4 5 2	2 4 1 3 1 1	3 1 0 0 3 1	4 1 0 5 6 1	
	8 12 19 13 5 4	7 3 2 2 7 4	5 2 2 3 0 4	1 1 0 3 3 0	3 2 7 4 4 3	689
			White arsenic			
3	E. to W.					
	13 6 1 3 2 1	3 2 4 0 1 1	3 4 1 3 3 6	1 3 1 0 3 1	1 0 2 6 2 4	
	13 3 3 1 3 5	2 5 3 4 9 2	3 5 0 2 2 3	3 1 5 3 1 5	0 2 2 3 3 10	
	W. to E.					
	1 1 3 1 2 3	1 3 2 1 1 2	4 1 2 4 3 0	2 2 0 1 2 3	2 5 4 5 0 6	
	2 1 3 4 3 1	1 2 2 0 2 4	0 0 1 5 4 0	2 0 4 1 3 2	0 5 4 0 5 0	

Table 2. Cont.

Plot no.	Grasshoppers caught in net after 36 uniform sweeps for each station: Station 1	Station 2	Station 3	Station 4	Station 5	Total
	White arsenic (cont.)					
	E. to W.					
	5 4 3 0 1 4	1 0 2 0 1 2	1 0 0 1 0 2	3 0 2 4 5 3	4 4 7 3 2 0	
	4 5 3 5 0 4	1 1 0 1 1 4	1 1 6 0 3 2	0 2 3 0 1 4	2 3 2 1 2 0	422
	Aldrin					
4	W. to E.					
	7 0 5 4 4 3	1 2 4 1 4 2	0 0 1 5 1 5	2 0 0 3 4 1	1 1 3 1 0 5	
	1 6 0 3 5 3	4 0 3 5 2 1	1 2 1 5 2 1	2 1 1 1 2 2	1 1 3 1 0 5	
	E. to W.					
	3 2 3 0 1 2	1 2 0 0 2 0	0 3 2 3 1 1	1 0 0 0 2 4	1 1 0 1 1 4	
	1 5 3 5 1 1	3 2 3 4 0 3	0 4 3 3 2 1	2 0 4 2 2 4	4 1 1 1 2 1	
	W. to E.					
	4 3 0 4 2 0	4 0 1 5 1 0	0 0 0 4 0 2	2 1 1 1 2 2	4 2 2 4 0 0	
	0 1 2 2 2 7	0 2 1 1 3 0	0 0 2 0 1 4	4 3 0 2 1 1	1 3 7 0 1 0	344
5	(The count on this plot was inadvertently missed.)					
	Check					
6	E. to W.					
	5 2 4 4 3 11	1 3 2 0 5 6	9 4 5 4 9 7	10 8 7 4 3 3	2 8 6 1 1 0	
	3 4 2 2 1 11	0 7 5 2 4 5	4 15 15 9 3 10	11 10 17 2 5 10	6 12 14 7 1 4	
	W. to E.					
	0 3 1 11 5 12	6 9 10 18 9 11	3 2 2 10 16 1	5 1 0 5 4 7	4 12 1 0 3 7	
	1 6 3 3 3 17	8 8 8 1 17 21	2 5 12 5 8 18	6 6 4 1 7 8	15 2 25 1 0 4	
	E. to W.					
	1 2 7 10 2 2	3 1 0 0 1 2	1 3 4 2 2 1	7 4 2 9 6 4	3 2 1 7 1 7	
	1 3 12 2 11 16	1 6 6 0 9 8	4 0 2 1 2 5	2 14 13 2 8 9	2 8 15 8 5 18	621
	Chlordane					
7	E. to W.					
	4 2 1 0 0 0	1 1 0 0 0 1	3 1 0 0 6 0	4 2 6 0 0 1	1 3 0 1 0 4	
	1 5 2 0 1 0	1 0 1 1 2 1	0 3 4 1 1 6	3 2 1 0 0 1	0 4 7 2 0 6	

Table 2. Concl.

Plot no.	Grasshoppers caught in net after 36 uniform sweeps for each station					Total
	Station 1	Station 2	Station 3	Station 4	Station 5	
	Chlordane (cont.)					
	W. to E.					
	6 3 2 3 4 3	0 2 1 0 3 8	0 0 3 3 2 4	2 0 4 7 3 0	5 2 1 4 3 0	
	2 2 4 4 5 3	2 1 4 6 3 6	1 3 1 2 3 4	1 5 3 6 4 3	3 6 3 2 2 0	
	E. to W.					
	7 4 5 0 1 2	5 4 10 1 2 1	6 4 2 2 2 3	3 4 3 5 2 4	6 4 1 3 10 3	
	3 4 1 1 6 5	6 2 1 4 0 3	5 4 2 3 1 2	1 5 6 4 2 3	3 7 9 2 5 4	465
	Aldrin					
8	E. to W.					
	1 0 4 1 0 0	3 3 1 1 0 1	3 2 1 0 1 6	3 3 4 2 2 6	9 5 0 2 2 7	
	0 3 6 1 5 1	1 1 6 1 3 5	1 1 0 0 2 4	4 2 2 0 2 3	6 6 10 4 8 7	
	W. to E.					
	1 1 5 5 0 1	4 1 3 7 0 2	8 6 3 4 3 4	2 3 3 3 3 2	5 2 0 0 3 2	
	3 3 1 1 2 3	2 3 4 0 4 3	1 1 2 3 3 5	6 2 3 4 1 6	6 1 5 1 3 0	
	E. to W.					
	5 1 4 1 0 0	6 3 2 1 4 4	1 5 1 2 0 3	4 2 3 3 1 0	2 1 5 2 2 0	
	3 4 4 1 1 4	5 6 7 0 0 1	1 3 5 2 0 4	5 3 2 0 1 1	2 3 5 3 2 6	385
	White arsenic					
9	E. to W.					
	10 5 5 2 1 2	7 0 4 5 3 3	3 5 0 5 3 1	4 4 4 1 1 3	6 4 6 8 5 3	
	12 6 5 3 7 3	5 3 10 5 9 2	3 4 8 4 2 7	12 8 10 5 5 8	9 7 4 2 10 0	
	W. to E.					
	9 6 2 3 5 9	0 3 0 0 2 1	5 1 0 0 5 7	3 3 3 2 3 0	8 2 4 8 6 2	
	3 4 4 7 6 5	1 3 6 5 4 4	1 5 0 0 2 8	3 1 0 2 2 2	3 6 7 2 6 8	
	E. to W.					
	4 2 1 0 4 2	6 1 1 7 3 4	4 1 1 5 7 5	4 2 5 11 7 2	14 6 1 4 3 3	
	0 3 5 5 7 6	4 0 6 3 1 2	8 3 4 4 9 7	5 7 12 7 7 7	6 8 10 12 8 7	795

Table 3. Grasshopper populations on baited plots 24 hours after treatment with four toxicants at the ManKan Airport as determined by the sweep net method.

Plot no.	Grasshoppers caught in net after 36 uniform sweeps for each station: Station 1	Station 2	Station 3	Station 4	Station 5	Total
	Toxaphene					
1	W. to E.					
	4 7 6 3 3 2	3 10 5 0 3 1	2 4 3 0 3 2	2 9 7 3 3 1	0 2 3 3 2 2	
	3 2 0 2 3 2	2 0 2 1 1 1	1 2 1 2 4 1	1 1 1 2 3 4	5 2 1 5 1 1	
	E. to W.					
	2 1 2 4 1 4	0 1 3 1 1 2	0 0 0 0 1 0	0 3 2 1 1 0	0 3 2 2 4 3	
	1 0 5 1 1 0	2 1 1 0 0 0	1 1 4 2 4 4	1 0 1 1 1 2	0 1 2 1 3 1	
	W. to E.					
	2 2 5 5 5 4	2 4 1 3 4 4	0 2 3 0 0 0	0 0 0 0 2 0	2 0 0 3 0 2	
	2 4 4 5 6 2	1 8 7 2 3 0	0 3 1 0 1 0	0 1 0 0 0 0	0 2 6 1 0 0	356
	Chlordane					
2	W. to E.					
	4 3 8 2 1 1	3 0 2 2 2 1	0 0 0 1 0 0	2 0 3 2 1 1	1 0 4 1 1 5	
	5 5 4 3 1 1	1 0 3 2 0 0	0 1 0 0 0 1	3 1 1 1 1 1	0 5 6 0 1 0	
	E. to W.					
	4 2 7 17 14 5	1 2 0 6 21 3	1 2 2 2 0 1	0 0 1 2 0 3	0 4 3 8 6 4	
	4 4 4 8 0 6	0 0 0 7 2 6	0 2 1 5 3 3	0 0 1 0 1 0	1 2 1 4 3 1	
	W. to E.					
	3 2 2 9 10 5	2 2 0 3 6 0	19 2 2 9 3 2	10 7 6 4 0 2	2 1 2 4 2 8	
	0 3 5 11 6 2	9 2 1 8 7 2	5 3 6 1 0 4	6 5 6 1 1 3	4 1 2 1 0 2	524
	White arsenic					
3	W. to E.					
	3 4 10 5 1 3	7 3 0 1 2 4	3 2 6 2 1 2	4 12 10 4 7 9	3 4 10 1 1 2	
	2 11 3 1 0 0	2 0 0 2 1 2	1 2 3 4 4 7	7 5 13 4 6 0	9 3 3 3 2 10	
	E. to W.					
	7 8 3 1 4 17	4 1 6 3 2 1	2 0 2 6 4 1	5 2 4 13 1 5	1 3 6 6 3 6	
	4 5 0 7 11 6	7 8 3 12 11 1	1 0 1 3 3 4	0 0 1 1 3 5	3 6 5 4 4 5	

Table 3. Cont.

Plot no.	Station 1	Station 2	Station 3	Station 4	Station 5	Total
	Grasshoppers caught in net after 36 uniform sweeps for each station					
			White arsenic (cont.)			
	W. to E.					
	25 4 5 2 1 4	2 0 2 0 2 5	4 3 5 0 0 1	0 1 1 3 1 0	0 1 0 1 2 7	
	6 3 1 2 1 2	0 3 2 0 0 3	0 6 10 2 0 1	3 0 0 3 5 1	1 2 2 0 1 2	615
			Aldrin			
4	W. to E.					
	1 4 2 1 0 2	0 0 0 0 0 0	0 2 1 0 0 0	0 0 1 0 0 0	0 0 0 0 1 0	
	0 1 2 1 0 0	0 0 1 0 0 0	0 0 1 0 0 0	0 0 2 1 0 2	0 2 1 0 0 0	
	E. to W.					
	0 0 2 0 2 0	1 0 0 1 0 0	1 0 1 0 0 0	0 0 2 0 0 10	1 0 1 5 0 2	
	1 0 0 0 0 1	0 0 0 1 2 1	2 0 0 0 1 0	0 3 0 1 0 1	1 0 0 0 0 1	
	W. to E.					
	3 1 0 0 0 0	0 0 0 0 0 0	2 2 0 1 1 1	0 0 0 0 1 0	0 2 1 0 0 0	
	2 0 0 0 0 1	0 0 1 0 0 0	0 0 1 2 1 0	0 0 3 1 1 1	1 1 0 0 1 1	107
			Toxaphene			
5	W. to E.					
	0 0 2 2 2 0	0 1 1 0 0 1	0 0 5 0 2 4	1 0 1 3 1 1	1 1 2 0 0 0	
	0 0 0 0 2 0	0 1 1 0 2 0	1 3 0 0 0 2	0 0 0 2 3 2	3 1 1 1 1 0	
	E. to W.					
	2 1 0 0 0 1	0 1 0 2 2 0	0 0 0 1 0 0	1 1 1 2 1 1	1 0 0 2 2 3	
	3 2 0 2 2 0	0 0 5 1 0 1	1 0 0 1 5 1	1 0 0 0 2 2	0 0 0 2 3 3	
	W. to E.	(grass)				
	1 5 2 3 2 5	10 8 11 6 6 7	9 8 18 7 5 1	4 4 1 0 4 0	3 0 1 0 0 0	
	2 3 1 1 4 6	8 7 8 1 0 0	2 3 0 0 0 3	0 0 0 1 1 0	0 1 0 0 1 4	311
			Check			
6	E. to W.					(run way)
	0 1 2 0 1 2	4 6 3 6 4 1	2 2 2 10 9 9	4 0 3 8 7 3	1 2 1 10 24 26	
	0 1 3 0 1 1	6 3 7 6 6 5	12 16 20 10 11 7	8 7 2 4 3 10	11 4 8 14 14 30	

Table 3. Cont.

Plot no.	Grasshoppers caught in net after 36 uniform sweeps for each station					Total
	Station 1	Station 2	Station 3	Station 4	Station 5	
			Check (cont.)			
	W. to E.					
	16 10 7 3 6 2	3 6 1 2 0 2	1 5 2 1 2 1	2 4 1 2 0 0	1 0 0 1 3 0	
	12 15 2 4 2 1	3 0 0 2 1 1	1 3 2 1 1 4	0 1 2 0 0 1	2 3 0 1 1 2	
	E. to W.					
	6 1 1 3 3 2	5 2 4 4 1 0	0 1 2 6 2 1	0 1 0 0 1 1	0 1 1 6 2 0	
	0 0 1 3 1 0	0 1 3 1 2 4	0 3 0 4 1 6	0 4 0 3 3 1	0 1 1 12 11 1	665
			Chlordane			
7	E. to W.					
	0 0 0 2 0 1	0 1 2 0 2 1	0 0 0 3 1 0	0 1 1 0 1 0	0 0 0 0 0 1	
	1 0 2 2 2 0	0 1 0 4 3 4	0 0 4 4 1 0	0 0 0 1 0 0	0 0 0 0 2 0	
	W. to E.					
	0 1 1 1 0 0	0 1 2 4 1 0	2 2 3 0 0 1	1 4 1 2 2 0	2 3 1 2 0 2	
	1 1 0 0 0 0	0 2 2 1 0 0	0 0 1 4 0 1	0 1 1 1 2 0	0 1 5 0 1 2	
	E. to W.					
	0 0 0 2 4 1	1 0 0 3 0 1	1 2 1 2 0 1	1 0 0 1 0 1	0 1 2 0 0 1	
	2 1 0 0 1 1	0 2 3 0 0 1	0 2 0 0 0 0	0 3 3 0 0 2	0 0 0 1 0 0	172
			Aldrin			
8	W. to E.					
	3 1 0 0 0 3	3 1 3 2 0 0	2 1 0 0 1 0	0 1 1 0 0 0	1 0 1 3 1 1	
	0 2 1 5 4 1	0 0 1 2 0 2	0 0 1 1 1 0	1 0 1 0 2 1	0 1 1 2 2 1	
	E. to W.					
	2 0 0 1 0 1	2 0 1 1 2 0	1 1 0 2 0 4	0 1 0 0 3 0	0 1 2 4 2 1	
	0 0 0 0 0 1	1 1 0 2 3 2	2 4 2 0 1 2	2 2 0 1 0 3	0 1 0 1 1 2	
	W. to E.					
	1 2 0 2 2 0	0 1 0 4 2 1	0 1 2 3 1 1	0 0 1 2 4 0	0 0 1 3 3 0	
	0 0 0 1 2 3	1 0 1 1 0 1	1 0 0 1 0 0	0 0 0 0 1 0	0 0 1 2 2 0	185

Table 3. Concl.

Plot no.:	Grasshoppers caught in net after 36 uniform sweeps for each station					
	Station 1	Station 2	Station 3	Station 4	Station 5	Total
			White arsenic			
9	E. to W.					
	2 2 3 0 4 3	5 0 1 1 3 0	1 1 2 3 0 0	6 0 1 6 1 3	5 8 4 4 3 6	
	5 2 1 2 3 2	4 3 2 1 0 1	4 0 6 1 0 1	0 3 0 1 2 4	2 3 1 1 3 3	
	W. to E.					
	2 1 2 3 2 0	1 0 1 4 3 1	0 2 3 0 1 3	2 4 6 2 5 0	2 4 2 1 1 3	
	0 4 8 2 2 6	1 1 5 1 1 0	1 1 1 1 5 0	2 3 3 1 2 5	5 4 1 1 1 1	
	E. to W.					
	0 0 0 5 1 2	1 0 0 4 1 0	1 1 1 4 4 5	1 0 3 3 2 3	3 5 7 1 4 3 8	
	0 2 1 0 0 0	3 2 5 2 0 3	4 2 0 3 6 1	1 1 1 5 0 1	1 2 3 9 6 1	431

Table 4. Grasshopper populations on baited plots 72 hours after treatment with four toxicants at the ManKan Airport as determined by the sweep net method.

Plot no.	Grasshoppers caught in net after 36 uniform sweeps for each station: Station 1	Station 2	Station 3	Station 4	Station 5	Total
			Toxaphene			
1	W. to E.					
	2 1 1 0 1 1	0 1 1 1 1 0	1 4 0 4 5 0	3 5 4 0 2 2	0 0 4 6 2 3	
	0 3 3 0 3 0	0 0 0 0 1 0	1 0 0 1 1 0	0 1 0 2 2 1	3 2 0 1 4 1	
	E. to W.					
	1 2 0 1 0 0	0 1 0 2 1 0	0 0 1 0 1 0	2 0 0 0 1 0	5 1 0 0 2 2	
	1 1 1 1 0 2	0 0 1 0 0 0	0 0 3 0 0 1	0 0 0 0 0 3	0 0 0 0 0 3	
	W. to E.					
	4 2 2 1 0 2	3 1 1 1 1 1	3 0 0 0 0 0	0 0 0 0 0 2	0 1 0 0 0 0	
	0 4 1 1 2 2	1 1 4 0 6 3	2 0 0 0 0 0	0 1 0 0 1 0	0 2 1 0 0 0	195
			Chlordane			
2	E. to W.					
	2 0 0 1 0 1	0 1 1 3 2 0	0 0 1 0 0 0	2 0 1 2 0 1	0 0 0 0 3 2	
	1 0 0 0 1 0	0 1 1 2 0 1	0 0 0 1 0 0	0 1 2 0 0 0	0 0 0 1 5 3	
	W. to E.					
	3 0 0 0 0 0	1 1 0 0 2 0	4 1 2 2 2 1	4 3 5 2 2 0	5 3 7 2 3 4	
	4 0 2 1 0 0	0 0 0 0 0 0	1 1 0 2 1 1	0 0 0 1 1 1	3 6 2 2 3 0	
	E. to W.					
	3 1 1 2 5 0	1 1 2 2 0 0	1 3 2 2 0 4	3 2 1 0 0 3	3 2 1 1 2 3	
	0 1 3 3 1 0	4 1 1 0 0 0	3 2 1 3 1 1	4 1 5 3 1 2	0 3 0 3 3 2	239
			White arsenic			
3	E. to W.					
	0 1 0 4 2 4	2 1 4 3 3 3	4 1 2 0 4 1	0 1 0 3 0 3	0 1 0 2 0 1	
	2 0 1 4 4 3	1 3 3 5 3 3	7 5 1 3 5 3	2 1 1 1 6 2	1 2 1 1 1 0	
	W. to E.					
	2 1 0 2 1 1	4 0 2 2 4 4	2 4 3 0 4 1	2 3 1 3 2 2	1 1 3 1 0 2	
	4 3 1 3 3 1	1 0 9 4 3 4	1 1 3 1 3 4	3 1 9 1 2 2	0 1 4 3 1 1	

Table 4. Cont.

Plot no.	Station 1	Station 2	Station 3	Station 4	Station 5	Total
	Grasshoppers caught in net after 36 uniform sweeps for each station					
			White arsenic (cont.)			
	E. to W.					
	3 2 1 4 2 3	0 1 0 2 3 1	0 0 0 0 1 2	1 2 2 5 1 0	1 0 0 1 0 1	
	0 2 1 5 3 3	0 2 0 0 0 0	0 0 1 1 0 3	2 1 0 3 2 0	1 5 0 1 1 0	338
			Aldrin			
4	W. to E.					
	0 0 1 0 2 0	0 0 0 2 0 0	0 0 0 0 0 0	0 0 0 0 0 0	0 0 0 1 0 0	
	3 0 0 0 1 1	0 0 1 0 1 0	0 0 0 0 0 1	1 0 0 1 1 0	0 0 1 0 0 0	
	E. to W.					
	0 0 1 1 1 1	2 2 0 0 0 2	0 0 0 0 0 0	0 3 0 0 0 0	0 1 0 2 1 2	
	0 0 0 0 0 0	0 0 0 0 0 0	1 0 0 1 0 0	1 1 6 1 1 0	0 2 0 2 0 0	
	W. to E.					
	1 0 3 0 0 0	0 1 0 0 0 0	0 0 0 1 0 1	0 1 0 0 0 0	0 1 1 0 0 2	
	3 1 2 1 1 2	0 0 0 0 0 0	1 1 1 0 0 0	1 1 0 3 1 0	3 0 0 0 0 0	86
			Toxaphene			
5	E. to W.					
	0 2 1 0 0 1	0 0 1 0 1 0	1 1 1 0 0 1	1 2 1 0 1 1	1 0 1 0 0 1	
	0 1 1 1 1 0	1 2 1 0 0 0	2 1 2 0 0 1	1 2 1 0 0 1	1 1 0 1 0 0	
	W. to E.					
	0 2 0 1 1 0	1 1 1 1 0 0	1 0 1 1 0 0	0 0 2 0 0 1	0 1 0 0 2 0	
	1 1 0 0 0 0	0 0 0 2 1 0	0 2 0 1 2 0	0 0 0 0 2 1	0 1 0 1 0 0	
	E. to W.					
	0 1 1 1 0 3	2 0 0 2 1 0	0 0 0 2 1 1	2 0 0 0 0 0	3 0 0 0 2 1	
	1 1 1 0 1 1	1 0 1 0 0 2	1 0 1 0 4 1	1 0 1 0 0 2	0 1 3 0 0 0	121
			Check			
6	W. to E.					
	6 2 9 4 2 4	8 7 4 6 10 5	8 13 4 5 7 6	1 0 9 3 5 4	2 2 3 4 1 1	
	8 0 2 6 6 6	8 6 7 2 2 3	4 4 5 8 5 6	6 2 7 2 4 1	2 1 2 2 2 1	

Table 4. Cont.

Plot no.:	Grasshoppers caught in net after 36 uniform sweeps for each station					
	Station 1	Station 2	Station 3	Station 4	Station 5	Total
			Check (cont.)			
	E. to W.					
	3 2 1 1 0 1	1 3 1 2 1 0	2 0 2 4 4 0	1 1 0 9 8 1	0 3 2 5 3 2	
	2 4 1 1 1 2	2 1 2 2 2 3	1 1 1 2 2 2	1 1 0 1 2 5	2 5 5 6 3 7	
	W. to E.					
	2 0 3 2 1 0	2 2 0 1 0 1	0 0 2 4 2 2	2 2 0 6 5 4	3 7 5 0 5 2	
	1 1 3 1 0 2	0 1 4 1 0 0	1 0 0 2 2 1	5 2 2 1 0 3	3 7 5 0 5 2	480
			Chlordane			
7	W. to E.					
	1 1 0 2 0 0	1 3 4 1 1 1	0 0 0 1 1 0	1 0 0 0 0 0	1 0 1 0 1 3	
	0 0 0 0 0 0	0 2 0 1 0 0	1 0 0 0 1 0	2 1 2 0 0 1	1 0 0 0 0 1	
	E. to W.					
	4 0 2 2 0 1	1 0 1 2 0 1	0 0 0 2 1 0	0 0 1 2 1 0	0 1 0 2 0 1	
	3 2 0 0 1 0	3 0 5 2 1 0	0 1 2 4 0 2	0 0 1 0 2 3	0 0 0 1 1 0	
	W. to E.					
	0 0 1 0 0 0	0 0 0 0 0 0	0 3 0 0 0 0	0 0 1 0 0 0	0 1 1 0 1 0	
	0 0 1 0 0 0	1 0 0 0 0 0	0 0 0 0 1 2	1 0 2 0 0 0	0 1 0 0 1 0	115
			Aldrin			
8	E. to W.					
	0 0 1 2 0 1	0 0 0 0 0 1	0 0 0 1 0 1	0 1 0 1 1 0	2 0 1 1 0 0	
	0 0 0 1 1 0	1 0 0 0 0 0	0 0 0 0 0 1	0 0 1 0 1 0	2 1 1 0 3 1	
	W. to E.					
	0 0 0 2 1 0	1 0 1 0 0 0	1 0 0 0 0 2	1 0 2 2 0 0	0 1 3 0 0 1	
	0 1 2 0 0 0	1 0 0 1 0 0	0 0 0 0 0 1	0 0 2 1 0 0	0 1 0 0 0 1	
	E. to W.					
	0 0 0 1 0 0	3 0 0 2 0 0	0 0 0 2 2 0	1 0 1 1 0 0	0 1 1 0 0 2	
	0 0 2 1 2 0	2 0 0 0 1 0	1 0 0 0 1 0	1 0 1 1 0 0	0 1 1 0 0 2	90

Table 4. Concl.

Plot no.	Grasshoppers caught in net after 36 uniform sweeps for each station					Total
	Station 1	Station 2	Station 3	Station 4	Station 5	
			White arsenic			
9	W. to E.					
	3 3 0 1 0 0	2 1 1 1 2 4	0 0 3 1 0 1	0 0 2 0 0 1	0 0 0 1 0 1	
	0 2 0 3 1 2	3 3 2 1 1 0	1 2 1 1 2 0	1 0 0 2 3 0	0 0 0 0 1 5	
	E. to W.					
	0 2 0 3 1 2	3 3 2 1 1 0	1 2 1 1 2 0	1 0 0 2 3 0	0 0 0 1 1 5	
	0 1 0 3 1 0	1 1 2 0 1 0	0 0 0 1 3 1	2 0 1 0 3 1	2 3 1 1 4 5	
	W. to E.					
	2 1 1 0 2 2	5 1 0 3 1 0	0 0 1 0 0 2	0 0 1 0 1 0	0 1 3 0 2 0	
	0 1 0 3 0 3	1 0 1 1 0 0	1 2 3 0 0 2	3 0 1 1 0 1	0 2 1 0 0 2	187

Table 5. Grasshopper populations on baited plots 7 days after treatment with four toxicants at the ManKan Airport as determined by the sweep net method.

Plot no.	Grasshoppers caught in net after 36 uniform sweeps for each station					Total
	Station 1	Station 2	Station 3	Station 4	Station 5	
			Toxaphene			
1	W. to E.					
	3 1 1 1 1 0	1 0 1 1 0 1	2 2 1 1 1 0	0 1 0 0 0 0	0 0 0 1 1 0	
	0 1 0 0 0 0	0 1 0 2 0 3	1 1 2 1 0 0	0 0 0 0 0 0	0 0 0 0 0 0	
	E. to W.					
	1 0 0 0 0 0	0 0 0 0 0 0	0 0 0 0 0 0	0 1 1 1 1 0	4 1 3 2 0 1	
	1 0 0 0 0 1	0 0 0 0 0 1	1 3 0 0 0 0	0 0 0 0 0 0	1 1 10 1 0 2	
	W. to E.					
	6 1 4 1 3 0	1 0 0 1 0 1	0 0 0 0 0 0	4 2 0 2 1 0	2 0 0 0 0 1	
	1 2 5 4 5 2	0 0 0 2 2 2	1 0 3 0 0 1	3 1 2 0 0 0	2 0 3 5 4 3	155
			Chlordane			
2	W. to E.					
	2 2 1 2 2 3	0 0 0 2 0 2	0 0 0 1 0 0	1 2 1 0 2 3	2 2 2 3 0 0	
	1 1 1 0 1 1	0 1 1 1 1 1	0 0 0 1 0 0	0 0 0 2 1 1	1 4 1 0 0 0	
	E. to W.					
	0 0 1 0 0 0	0 5 2 1 0 0	0 0 1 0 0 0	0 0 0 0 0 1	1 2 0 0 0 2	
	0 2 0 0 0 1	0 0 0 0 0 0	0 2 3 0 0 1	0 0 0 2 0 1	1 0 0 1 1 2	
	W. to E.					
	3 3 1 0 0 1	0 0 0 0 1 0	0 1 0 0 1 0	1 0 0 1 1 0	4 1 1 0 0 0	
	2 4 0 0 1 1	2 0 0 0 0 1	5 3 1 0 0 0	1 0 0 0 0 0	5 1 0 3 1 0	140
			White arsenic			
3	W. to E.					
	2 2 2 3 2 1	2 1 0 1 1 0	0 2 1 2 1 2	0 3 1 3 1 2	0 2 0 1 0 1	
	5 1 2 0 1 0	0 0 0 0 0 5	0 1 4 4 3 3	1 2 0 1 0 2	0 0 0 3 1 2	
	E. to W.					
	2 0 0 1 1 2	4 5 8 3 3 0	1 0 0 5 2 4	3 2 3 3 4 3	3 5 7 1 4 1	
	0 0 0 1 2 1	2 7 3 1 2 0	2 1 1 3 1 6	2 2 1 0 1 3	10 9 8 0 1 1	

Table 5. Cont.

Plot no.	Grasshoppers caught in net after 36 uniform sweeps for each station					Total
	Station 1	Station 2	Station 3	Station 4	Station 5	
			White arsenic (cont.)			
	W. to E.					
	2 3 1 5 2 6	0 1 1 4 0 1	0 0 1 0 0 0	8 5 5 0 0 0	2 2 1 2 4 1	
	1 0 3 2 4 6	2 0 0 0 0 2	5 3 0 0 0 0	0 1 0 0 1 2	0 0 4 2 0 3	331
			Aldrin			
4	W. to E.					
	0 0 0 0 0 0	0 0 0 0 0 0	0 0 0 0 0 0	0 0 0 0 1 0	0 0 0 0 0 0	
	0 1 0 0 0 1	0 0 0 1 0 0	0 0 0 0 2 0	0 0 0 0 0 0	0 0 0 0 1 0	
	E. to W.					
	0 0 0 0 0 0	0 0 0 1 0 0	0 0 0 0 0 0	0 0 0 1 0 0	0 0 0 2 0 0	
	0 0 0 0 0 0	0 0 0 0 0 0	0 0 1 0 0 0	0 0 0 0 0 1	0 0 0 0 0 0	
	W. to E.					
	0 1 1 0 0 1	1 0 0 0 0 0	0 0 0 0 1 0	1 0 0 0 0 1	0 0 0 1 0 1	
	6 1 3 0 0 0	0 1 0 0 0 1	0 0 1 0 0 0	1 1 1 1 0 0	0 0 0 0 1 0	40
			Toxaphene			
5	E. to W.					
	0 0 1 0 0 1	1 0 2 2 2 2	3 1 2 1 0 2	1 1 3 3 5 3	1 1 2 1 2 1	
	0 0 1 2 2 0	0 0 0 0 0 1	0 1 2 2 2 2	4 2 2 1 0 4	0 3 3 4 2 2	
	W. to E.					
	0 0 1 0 0 1	1 0 1 2 3 0	0 0 3 1 0 0	0 1 0 1 1 2	4 1 1 0 0 2	
	0 0 1 0 1 0	1 0 1 0 0 3	2 0 1 1 1 1	1 0 1 3 1 0	1 2 1 0 1 3	
	E. to W.					
	2 1 1 0 1 1	1 3 0 1 2 3	1 0 3 4 0 1	0 0 2 0 1 0	0 1 0 2 1 0	
	0 1 0 3 0 3	2 0 1 0 1 2	0 1 0 1 0 0	0 1 1 2 1 0	0 0 0 0 2 2	195
			Check			
6	W. to E.					
	2 2 3 10 10 5	9 5 5 12 12 8	6 5 8 10 7 8	5 5 3 10 3 6	0 5 2 3 2 4	
	3 4 13 1 3 5	6 3 5 4 5 3	5 9 10 7 5 11	2 2 5 4 4 8	2 2 3 2 1 11	

Table 5. Cont.

Plot no.	Station 1	Station 2	Station 3	Station 4	Station 5	Total
	Grasshoppers caught in net after 36 uniform sweeps for each station					
			Check (cont.)			
	E. to W.					
	0 0 1 4 2 1	0 0 1 1 0 0	0 0 0 2 0 3	3 1 2 1 2 1	1 1 4 4 1 1	
	0 0 0 1 0 0	1 3 2 0 1 3	1 0 2 2 0 0	0 0 0 0 2 1	0 1 1 2 0 0	
	W. to E.					
	1 1 0 1 0 0	0 3 1 1 0 0	2 2 3 1 2 0	1 1 0 3 1 2	0 2 0 0 1 2	
	1 2 1 1 7 5	1 2 3 1 3 7	2 2 3 1 2 0	2 1 5 0 1 2	0 1 1 0 1 1	480
			Chlordane			
7	E. to W.					
	0 2 0 0 1 1	0 2 0 1 1 1	0 0 1 1 0 0	0 0 1 1 0 0	1 0 0 0 0 3	
	0 1 0 0 0 0	0 1 1 1 0 1	1 1 0 0 0 0	0 1 0 0 0 0	2 1 0 1 1 0	
	W. to E.					
	0 0 0 0 0 0	1 0 0 0 0 1	0 0 0 1 1 0	1 1 0 1 0 0	1 1 1 1 1 1	
	0 0 0 2 1 1	1 0 0 0 0 0	0 0 0 1 0 2	0 0 2 0 0 1	1 0 1 1 1 0	
	E. to W.					
	0 0 1 0 0 0	1 0 1 3 0 0	0 0 0 3 0 0	0 2 3 1 1 0	0 0 2 1 3 2	
	0 1 1 0 0 2	0 0 0 0 1 1	0 5 0 1 2 2	2 3 3 0 0 1	3 1 2 4 1 2	122
			Aldrin			
8	W. to E.					
	0 1 0 0 1 0	3 0 0 0 2 1	1 0 3 0 1 2	0 1 0 2 0 0	0 0 1 1 1 0	
	0 0 2 2 2 0	1 0 0 0 0 0	0 0 0 3 2 2	0 1 0 0 0 0	0 0 0 1 0 0	
	E. to W.					
	0 1 1 0 1 1	0 0 3 0 0 0	0 0 0 2 0 0	0 0 0 0 1 0	0 1 0 0 1 0	
	0 0 3 0 2 1	0 1 0 1 2 3	0 1 1 2 0 0	0 1 0 0 0 0	0 1 1 0 0 0	
	W. to E.					
	1 0 3 2 1 1	1 0 0 0 0 0	0 1 0 0 0 0	0 1 1 0 0 0	0 0 0 0 1 1	
	1 1 0 1 1 1	0 0 0 0 1 0	0 0 0 0 0 1	0 0 0 0 0 0	1 0 0 2 1 1	95

Table 5. Concl.

Plot no.:	Grasshoppers caught in net after 36 uniform sweeps for each station: Station 1	Station 2	Station 3	Station 4	Station 5	Total
			White arsenic			
9	E. to W.					
	2 0 1 1 1 0	0 1 2 0 0 0	0 0 0 0 0 0	1 0 1 5 4 1	4 3 2 6 3 5	
	0 0 0 2 1 0	1 1 0 0 1 1	2 1 0 1 0 2	1 0 0 1 1 4	6 5 2 4 7 2	
	W. to E.					
	0 0 2 1 3 3	2 2 1 3 2 1	0 1 2 0 1 0	2 2 1 2 3 1	0 1 4 3 1 1	
	3 3 1 4 2 4	2 0 3 0 1 0	1 1 2 1 1 3	2 3 3 2 1 1	8 1 0 8 2 1	
	E. to W.					
	0 2 2 1 3 1	4 2 0 2 2 1	1 3 1 1 1 0	6 6 4 2 2 3	0 3 1 3 4 5	
	1 0 3 2 1 2	1 1 0 1 0 1	1 0 2 0 2 0	1 1 7 1 3 7	5 1 0 3 5 2	331

This experiment was divided into two phases, namely, those plots baited in the early morning and those baited in the early afternoon. Four applications were made in the morning between 5:18 and 6:27 A. M. at temperatures that ranged between 74° F. and 78° F. Four applications were made in the afternoon of the same day between 2:50 and 3:47 P. M. at the temperature of 89° F.

The morning applications included toxaphene at 0.1 pounds, chlordane at 0.05 pounds, aldrin at 0.0124 pounds, and white arsenic at 6.4 ounces per acre. The afternoon applications were replicates of the morning applications.

The following results were obtained when the materials were applied in the morning (Figure 3 and Table 6). Toxaphene at 0.1 pounds per acre showed a 46 per cent reduction of grasshoppers at 24 hours, a 59 per cent reduction at 72 hours, and a reduction of 67 per cent seven days after application. Chlordane at 0.05 pounds per acre showed a 21 per cent reduction in grasshoppers 24 hours after application, a 50 per cent reduction at 72 hours, and a 70 per cent reduction at seven days. White arsenic at 6.4 ounces per acre showed at 24 hours after application a 7 per cent reduction, at 72 hours a 29 per cent reduction, and at seven days a 31 per cent reduction in population. Aldrin at 0.0124 per acre showed an 83 per cent reduction in population at 24 hours after treatment, 82 per cent reduction at 72 hours after treatment, and a 90 per cent reduction at seven days.

The afternoon treatments were replicates of the morning applications, and the results were: toxaphene at 24 hours, 54.7 per cent reduction in population, at 72 hours a 74.7 per cent reduc-

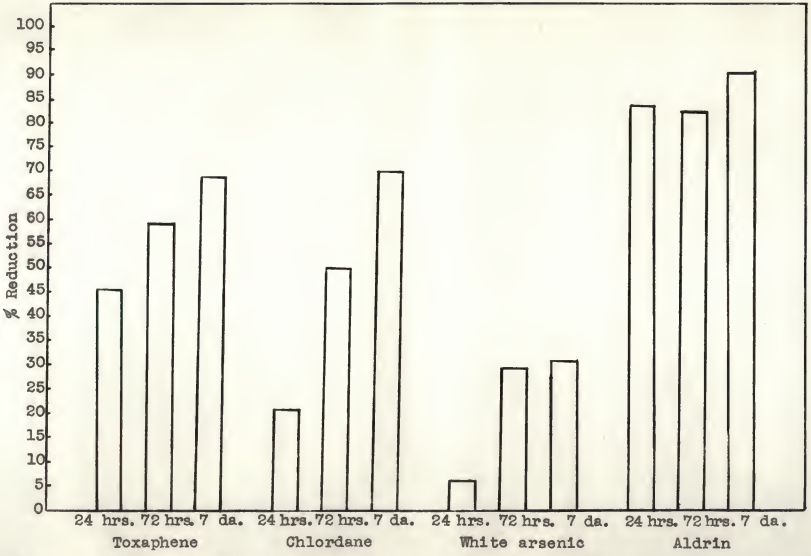


Fig. 3. The percentage and comparative rate of reduction of grasshoppers in alfalfa at 24 hours, 72 hours, and 7 days, of four poison bran baits applied in the morning between 5:18 and 6:45 a.m. at temperatures from 74° F. to 78° F.

Table 6. Effectiveness of four toxicants when used in baits against grasshoppers in alfalfa at ManKan Airport, Pottawatomie County, Kansas, from June 24 to July 2, 1949.

Material	Lbs. of actual toxicant per acre	Temperature when applied	Time	% Reduction of grasshoppers		
				24 hrs.	72 hrs.	7 days
Morning applications						
Toxaphene	0.1	74° F	5:18-5:30	46	59	67
Chlordane	.05	77° F	5:50-6:09	21	50	70
White arsenic	.40	78° F	6:27-6:45	7	29	31
Aldrin	.0124	77° F	6:09-6:27	83	82	90
Afternoon applications						
Toxaphene	0.1	89° F	3:47	54.7	74.7	59
Chlordane	.05	89° F	3:34	75	76	74
White arsenic	.40	89° F	2:50	35	61	31
Aldrin	.0124	89° F	3:15	72	81	80

tion in population, and at 7 days a 59 per cent reduction was noted. Chlordane at 24 hours showed a 75 per cent reduction in grasshopper population, at 72 hours a 76 per cent reduction, and at 7 days a 74 per cent reduction. White arsenic at 24 hours after application showed a 35 per cent reduction, at 72 hours a 61 per cent reduction, and at 7 days a 31 per cent reduction. Aldrin in 24 hours showed a 72 per cent reduction in population, at 72 hours an 81 per cent reduction, and at 7 days an 80 per cent reduction (Figure 4 and Table 6).

Baiting - Geary County

A check was made at the end of one week after the application of the material to the alfalfa. It was found that the alfalfa in the treated portion of the fields showed very good growth while that alfalfa in the untreated plots showed no new growth because of the feeding of the grasshoppers. At two weeks after application, the treated portions of the field showed a very lush growth of alfalfa. The untreated portions were still in the condition of little or no vegetation as they were before the treated areas of the other portions.

A narrow lane separated the two fields, which are hereafter referred to as the north and south fields.

Figure 5 shows the approximate shape of the fields treated. Plates II through VIII show the progress of the baiting experiment.

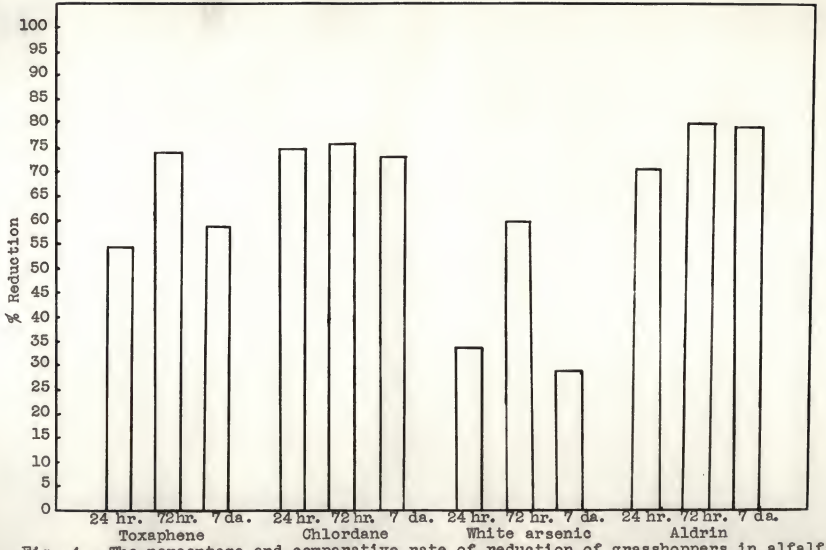


Fig. 4. The percentage and comparative rate of reduction of grasshoppers in alfalfa at 24 hours, 72 hours, and 7 days, of four poison bran baits applied in the afternoon between 2:50 and 3:47 P.M. at a temperature of 89° F.

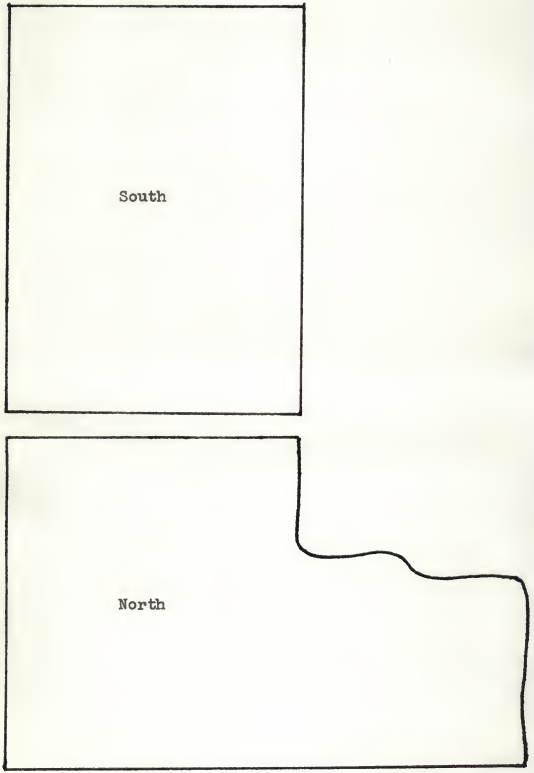


Fig. 5. Approximate shape of alfalfa fields treated with poison bran at the Hickman Farm to control M. bivittatus Say.

EXPLANATION OF PLATE II

Fig. 6. The trailer bed in which the aldrin and bran were mixed. The handle of the shovel used for mixing the bait, the jar containing the aldrin, the measuring cup, and the top of the sprayer are shown in the foreground with the bran being in the background.

Fig. 7. Close-up of defoliated alfalfa plants at the Hickman farm showing a grasshopper on a bare alfalfa stem.

PLATE II

Fig. 6

Fig. 7

EXPLANATION OF PLATE III

Fig. 8. Section of check plot in the south field on the Hickman farm, Geary County, before application of aldrin baits.

Fig. 9. Another section of the check plot described in Figure 8.

Fig. 10. The north field of the Hickman farm before treating.

PLATE III

Fig. 8

Fig. 9

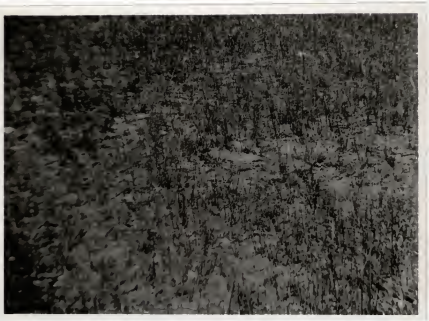


Fig. 10

EXPLANATION OF PLATE IV

Fig. 11. Alfalfa in the check plot in the north field of the Hickman farm before treatment showing severe grasshopper damage.

Fig. 12. Alfalfa in the north plot of the Hickman farm one week after treatment.

PLATE IV

Fig. 11

Fig. 12

EXPLANATION OF PLATE V

Fig. 13. The south field at the Hickman Farm one week after treatment showing slight recovery from grasshopper attack.

Fig. 14. The alfalfa in the immediate foreground serves as a check portion of the south field at the Hickman Farm one week after treatment of the rest of the field.

PLATE V

Fig. 13

Fig. 14

EXPLANATION OF PLATE VI

Fig. 15. The south field at the Hickman Farm, two weeks after treatment, showing continued damage to the alfalfa by the grasshoppers.

Fig. 16. The check plot at the south field at the Hickman Farm, two weeks after treatment, showing continued damage to the alfalfa by grasshoppers.

PLATE VI

Fig. 15

Fig. 16

EXPLANATION OF PLATE VII

Fig. 17. The check of the north field at the Hickman Farm, two weeks after treatment of the rest of the field, showing continued damage to the alfalfa by grasshoppers.

Fig. 18. Treated and untreated portions of the north field two weeks after application. The darker portion at the right of photograph is the treated portion, while the lighter area on the left is the check.

PLATE VII

Fig. 17

Fig. 18

EXPLANATION OF PLATE VIII

Fig. 19. Portion of north field of the Hickman Farm, two weeks after applications of baits, showing alfalfa recovery.

Fig. 20. Portion of north field of the Hickman Farm, two weeks after applications of baits, showing alfalfa recovery.

PLATE VIII

Fig. 19

Fig. 20

Spraying - ManKan Airport

Grasshoppers. After the insecticides--chlordane, toxaphene, and aldrin--were sprayed, each plot was checked for grasshoppers just before spraying at 24 hours, 72 hours, and 7 days, respectively.

The unit grasshopper counts obtained by the sweep net method are shown in Tables 7 through 10.

Table 7. Grasshopper populations on sprayed plots immediately before treatment with three toxicants at the ManKan Airport as determined by the sweep net method.

Plot no.	Grasshoppers caught in net after 36 uniform sweeps for each station					Total
	Station 1	Station 2	Station 3	Station 4	Station 5	
			Chlordane			
1	2 9 4 2 6 3	6 5 3 4 2 3	5 1 2 3 7 3	2 2 0 1 1 1	4 5 0 3 5 5	
	6 5 2 3 2 3	6 6 4 1 3 2	1 5 5 4 6 5	1 5 1 3 3 3	3 2 2 4 11 3	
	1 1 1 1 1 2	1 5 8 1 2 2	3 4 0 2 2 1	0 1 2 2 1 1	0 0 2 1 2 3	
	1 1 0 3 3 3	4 8 5 3 1 2	0 2 2 1 0 0	0 1 2 2 0 2	0 1 0 1 1 4	
	1 0 1 1 2 1	0 1 1 0 0 1	4 0 0 3 3 1	7 10 6 1 3 0	5 8 1 5 3 2	
	1 0 1 3 0 0	0 0 0 2 0 0	4 3 2 0 1 1	3 2 1 2 2 0	9 9 8 5 5 8	463
			Toxaphene			
2	3 4 3 0 6 7	5 4 2 3 0 1	2 2 0 3 2 2	1 0 3 0 2 3	4 4 1 8 4 1	
	1 1 1 1 7 16	0 1 0 0 0 2	1 0 1 3 1 2	1 3 1 0 3 7	5 9 8 6 11 4	
	0 2 0 0 1 4	1 2 0 0 2 1	0 0 0 2 0 0	1 0 5 0 1 2	1 1 0 0 0 0	
	1 1 0 2 0 2	1 0 0 2 2 0	0 1 2 0 2 2	0 5 2 2 0 0	2 8 5 3 1 12	
	1 3 0 2 4 0	1 2 1 1 0 0	1 1 1 0 0 0	0 0 0 1 0 0	0 0 0 1 1 0	
	1 0 4 0 5 1	0 0 1 0 1 2	0 0 5 3 1 1	0 0 1 0 0 0	0 0 1 0 1 3	312
			Aldrin			
3	3 0 2 3 2 2	4 6 3 2 4 6	1 4 3 0 0 0	0 0 0 0 0 0	0 0 0 0 0 0	
	2 6 5 6 4 12	8 8 4 10 5 3	9 3 8 3 2 1	5 10 12 3 1 1	2 10 9 3 2 1	
	8 3 6 8 8 6	4 0 0 0 1 0	0 0 0 0 0 2	0 0 0 1 0 0	0 0 0 0 0 0	
	7 3 1 4 0 5	4 0 1 3 2 1	0 0 1 0 2 3	0 0 0 0 0 3	0 0 2 1 2 1	
	2 3 0 1 1 2	1 0 1 2 0 1	2 0 1 0 0 0	2 2 1 0 2 4	0 3 3 0 0 0	
	2 3 1 1 0 2	2 2 5 0 2 1	0 0 5 1 0 0	1 0 4 0 1 0	1 4 3 0 0 1	367
			Toxaphene			
4	2 3 0 5 4 7	3 1 0 0 0 2	1 2 2 2 1 3	0 0 0 2 0 3	0 0 0 3 0 2	
	3 2 1 5 4 14	5 5 3 2 1 6	0 1 0 3 3 2	0 5 3 2 3 3	0 0 0 6 3 5	

Table 7. Cont.

Plot no.	Station 1	Station 2	Station 3	Station 4	Station 5	Total
			Toxaphene (cont.)			
	2 1 6 4 3 3 1 2 2 8 5 4	1 2 12 2 3 2 6 1 8 2 5 4	6 6 8 5 6 2 13 8 5 20 5 2	20 15 7 8 1 1 10 17 11 3 1 5	3 3 0 8 11 7 2 2 2 2 5 9	
	5 3 1 4 12 15 3 3 0 12 0 12	1 4 2 5 8 8 5 5 8 6 5 11	8 9 1 8 2 10 5 5 4 5 0 6	1 0 0 8 7 4 1 3 4 10 12 10	5 6 1 5 1 1 0 15 2 5 2 3	784
			Aldrin			
5	1 1 1 0 0 1 0 0 1 0 1 2	0 1 2 0 0 0 0 1 0 0 1 6	0 0 2 4 4 0 3 0 0 0 0 3	1 2 1 1 3 0 3 1 0 2 1 1	1 0 1 3 5 2 2 1 0 1 5 4	
	5 4 3 0 2 1 2 4 3 2 1 1	5 3 3 0 0 0 1 4 1 0 3 1	2 3 1 2 0 3 1 0 0 0 3 2	0 2 1 0 2 1 1 0 1 2 2 0	0 1 0 1 0 1 0 1 0 2 3 1	
	0 1 1 4 1 0 0 0 1 1 1 1	0 2 0 1 1 1 3 3 2 1 0 0	0 0 2 3 0 0 2 1 1 1 1 2	3 0 0 0 0 3 0 1 1 0 0 1	4 2 2 3 1 1 2 4 2 1 2 2	238
			Chlordane			
6	6 10 1 3 3 1 3 9 12 6 2 8	3 3 2 4 2 3 3 3 5 4 3 3	1 3 2 7 1 0 2 2 1 1 4 3	1 4 0 0 1 2 3 2 1 1 1 0	1 0 1 1 3 2 1 4 0 3 0 2	
	5 0 3 5 3 6 1 2 1 0 2 1	2 1 5 3 5 5 2 0 0 0 1 2	4 3 1 3 5 2 5 2 5 0 2 3	6 4 1 5 5 7 11 3 1 2 2 6	1 0 3 3 5 4 2 1 3 2 2 0	
	3 0 0 0 0 2 0 2 3 2 7 2	1 1 0 1 0 1 4 3 8 3 1 0	0 0 1 1 3 1 0 1 2 3 3 6	4 4 2 2 2 5 1 0 0 1 0 0	1 2 3 5 6 4 0 4 1 2 6 9	467
			Check			
7	5 3 1 1 4 1 0 3 2 4 1 3	2 3 1 1 0 2 0 3 2 4 1 3	9 4 2 0 0 1 1 0 0 0 0 3	1 1 3 3 0 1 7 1 1 0 1 5	2 1 1 3 1 4 0 1 1 2 3 0	
	8 3 4 2 1 2 5 3 11 2 1 4	2 1 1 0 0 1 1 0 4 2 0 1	0 1 0 3 1 0 0 2 2 5 1 0	0 1 0 3 1 0 3 0 0 1 2 2	0 0 1 2 1 3 1 2 1 0 1 1	

Table 7. Concl.

Plot no.	Grasshoppers caught in net after 36 uniform sweeps for each station: Station 1	Station 2	Station 3	Station 4	Station 5	Total
Check (cont.)						
	6 3 2 5 0 2 3 1 4 2 1 5	5 2 1 1 2 4 6 2 4 0 2 5	2 1 0 1 1 1 2 3 5 3 1 4	5 0 0 3 4 0 1 5 0 2 4 3	3 7 1 4 2 1 0 5 2 6 3 5	381

Table 8. Grasshopper populations on sprayed plots 24 hours after treatment with three toxicants at the ManKan Airport as determined by the sweep net method.

Plot no.	Grasshoppers caught in net after 36 uniform sweeps for each station: Station 1	Station 2	Station 3	Station 4	Station 5	Total
			Chlordane			
1	0 0 0 0 0 0 0 0 0 0 0 0	0 0 0 0 0 0 0 0 0 0 1 0	0 0 0 0 0 0 0 0 1 0 0 0	0 1 0 0 1 0 0 0 1 0 0 1	0 0 0 1 0 0 1 0 0 0 0 0	
	0 0 1 0 0 0 0 3 0 0 0 1	0 0 0 0 0 0 0 1 0 0 0 0	0 0 0 0 0 0 0 0 0 0 0 0	0 0 0 0 0 0 0 0 1 0 0 1	0 0 0 0 0 0 0 0 0 0 1 0	
	0 0 0 0 0 1 0 0 0 0 0 0	1 0 1 0 0 1 0 0 0 0 1 0	0 0 0 0 0 1 0 0 0 0 0 0	0 0 0 0 0 0 0 0 0 0 1 1	0 0 0 0 0 1 0 0 1 0 0 0	27
			Toxaphene			
2	1 0 0 0 0 0 0 0 0 1 0 0	0 0 0 0 0 0 0 0 0 0 0 0	0 0 0 0 2 1 0 0 0 0 0 0	0 0 0 0 1 0 0 0 0 0 0 1	0 0 1 0 0 0 0 2 1 0 0 0	
	0 0 0 0 0 0 0 0 0 0 0 0	0 0 0 0 0 0 0 0 0 0 0 0	0 1 0 0 0 1 1 0 1 0 0 0	1 0 0 0 0 0 0 0 0 1 0 0	0 0 0 0 0 0 0 0 0 0 0 0	
	0 0 0 0 0 0 0 0 0 1 0 0	0 0 0 0 0 0 0 0 0 0 0 0	0 0 0 0 0 1 0 0 0 0 0 0	0 0 0 1 0 1 0 0 1 0 0 0	0 0 0 0 0 0 0 0 0 0 0 0	22
			Aldrin			
3	0 0 0 0 0 0 0 0 0 0 0 0	0 0 1 0 0 0 0 0 0 0 0 0	0 0 0 1 0 0 0 0 0 0 0 0	0 0 0 0 0 0 0 0 0 0 0 0	0 1 0 0 0 0 0 0 0 0 0 0	
	1 0 0 0 0 0 0 0 0 0 0 0	0 0 0 1 0 0 0 0 0 0 0 0	0 0 0 0 0 0 0 0 0 0 0 0	0 0 0 0 0 0 0 0 0 0 0 0	0 0 0 0 0 0 0 0 0 0 0 0	
	0 0 1 0 0 0 0 0 0 0 0 0	0 0 0 0 0 0 0 0 0 0 0 0	0 0 0 0 0 0 0 0 0 0 0 0	0 0 0 0 0 0 1 0 0 0 0 0	0 0 0 0 0 0 1 0 0 0 0 0	8
			Toxaphene			
4	0 0 4 0 1 0 0 0 1 0 4 2	0 0 0 1 0 1 1 0 1 0 0 1	1 0 0 1 2 1 0 0 1 0 1 1	1 0 0 0 0 0 0 1 0 1 2 2	0 0 0 0 0 0 0 1 2 0 0 1	
	1 1 0 0 1 0 1 0 1 0 0 0	0 0 0 0 0 0 0 1 3 0 0 0	0 2 0 0 0 0 0 0 1 1 0 0	1 0 0 0 0 0 2 1 1 1 0 0	0 0 1 1 1 0 2 2 0 0 0 2	

Table 8. Concl.

Plot no.	Grasshoppers caught in net after 36 uniform sweeps for each station: Station 1	Station 2	Station 3	Station 4	Station 5	Total
			Toxaphene (cont.)			
	0 1 3 2 3 1 1 3 2 0 1 1	2 3 0 1 2 3 0 0 2 0 1 1	1 0 0 0 0 0 1 1 1 1 0 0	0 0 0 1 1 0 1 0 1 0 0 1	0 1 0 2 0 0 0 0 0 1 4 3	118
			Aldrin			
5	0 0 0 0 0 1 0 0 0 0 0 0	0 0 0 0 0 0 0 0 0 0 0 0	0 0 0 0 0 0 0 0 0 0 0 0	0 0 0 0 0 0 0 0 0 0 0 0	0 0 0 0 0 0 0 0 1 0 0 0	
	0 0 0 0 0 0 0 0 0 0 0 0	0 0 0 0 0 0 0 0 0 0 0 0	0 0 0 0 0 0 0 0 0 0 0 0	0 0 0 0 0 0 0 0 0 0 0 0	0 0 0 0 0 0 1 0 0 0 0 0	
	0 0 0 0 0 0 0 0 0 0 0 0	0 0 0 0 0 0 0 1 1 0 0 0	0 0 0 0 0 0 0 0 0 0 0 0	0 0 0 0 0 0 0 0 0 0 0 0	0 0 1 0 0 0 0 0 1 0 0 0	7
			Chlordane			
6	1 3 0 0 1 0 1 1 0 0 0 0	1 0 1 1 1 1 0 0 0 3 0 0	1 0 1 1 1 0 0 0 0 0 0 1	0 0 0 0 1 0 0 0 0 0 0 0	0 0 0 0 0 0 0 0 0 0 0 0	
	0 0 0 1 0 0 1 0 0 0 0 0	2 0 0 0 0 0 1 0 1 0 0 0	1 0 0 0 0 0 0 0 0 0 0 0	0 0 0 0 0 0 0 0 0 0 0 0	0 0 0 0 1 0 0 0 0 0 1 0	
	0 0 0 0 0 0 0 0 0 1 0 0	0 1 0 0 0 1 0 0 0 0 0 0	1 1 1 0 0 1 0 0 0 0 0 0	1 0 1 2 0 0 0 0 0 0 0 0	0 1 1 0 1 0 0 0 0 0 1 0	43
			Check			
7	0 2 0 3 2 2 5 8 1 0 3 2	2 0 4 2 0 3 2 2 5 2 2 4	2 0 0 3 4 2 1 1 3 1 3 3	1 3 0 4 0 1 3 5 3 1 2 1	1 2 0 4 1 1 1 1 1 1 2 1	
	1 1 1 0 0 3 1 0 0 0 1 1	4 1 2 0 3 0 2 0 1 0 2 6	2 2 0 1 1 3 0 1 1 2 4 0	1 2 1 0 3 0 1 0 1 1 0 0	5 0 1 2 0 1 0 0 0 1 1 1	
	2 5 1 2 0 0 2 4 0 1 3 2	1 2 0 3 0 2 2 0 1 0 0 4	1 2 1 0 0 0 1 1 1 1 1 3	2 2 2 0 4 2 1 2 0 1 2 2	0 0 0 5 2 2 2 1 0 7 5 4	283

Table 9. Grasshopper populations on sprayed plots 72 hours after treatment with three toxicants at the ManKan Airport as determined by the sweep net method.

Plot no.	Grasshoppers caught in net after 36 uniform sweeps for each station: Station 1	Station 2	Station 3	Station 4	Station 5	Total
			Chlordane			
1	0 0 0 0 0 0 0 1 0 0 0 0	0 0 0 0 0 0 0 0 0 0 0 0	0 0 0 0 0 0 0 0 0 0 0 0	1 1 0 0 1 0 0 0 0 0 0 0	0 1 1 1 0 0 0 0 1 0 0 0	
	0 0 0 0 0 0 0 0 0 0 0 0	0 0 0 0 0 0 1 0 0 0 0 0	0 0 0 0 1 0 3 0 0 2 0 1	0 0 1 0 0 0 0 0 1 0 0 0	0 0 0 0 0 0 0 0 0 0 1 0	
	0 0 0 0 0 0 0 0 1 0 0 0	0 0 0 0 0 0 0 0 0 0 0 0	0 0 0 0 0 0 1 0 0 0 0 0	0 0 0 0 0 0 0 0 0 0 0 0	0 0 0 0 0 0 0 0 0 0 0 0	21
			Toxaphene			
2	0 0 0 0 0 0 0 0 0 1 0 0	0 0 0 0 0 0 0 0 0 0 0 0	0 0 0 0 0 0 0 0 0 0 0 0	0 0 0 0 0 0 0 0 0 0 0 0	0 0 0 0 0 0 0 0 0 0 0 0	
	0 0 0 0 0 0 0 0 0 0 0 0	0 0 0 0 0 0 0 0 0 0 0 0	0 0 0 0 0 0 0 0 0 0 0 0	0 0 0 0 1 0 0 0 0 0 0 1	0 0 0 0 0 0 1 0 0 0 0 0	
	0 0 0 0 0 0 0 0 0 0 0 1	0 0 0 0 0 0 0 0 0 0 0 0	0 0 0 0 0 0 0 0 0 0 0 0	0 0 0 0 0 0 1 0 0 0 0 0	0 0 0 0 0 0 0 0 0 0 0 0	6
			Aldrin			
3	0 0 0 0 0 0 0 0 0 0 0 0	0 0 0 0 0 0 0 0 0 0 0 0	0 0 0 0 0 0 0 0 0 0 0 0	0 0 0 0 0 0 0 1 0 0 0 0	0 0 0 0 0 0 0 0 0 0 0 0	
	0 2 0 0 0 0 0 0 0 0 0 0	0 0 0 0 0 0 0 0 0 0 0 0	0 0 0 0 0 0 0 0 0 0 0 0	0 0 1 0 0 0 0 1 0 0 0 0	0 0 0 0 0 0 0 0 0 0 0 0	
	1 0 0 0 0 0 0 0 0 0 0 0	0 0 0 0 0 0 0 0 0 0 0 0	0 0 0 0 0 0 0 0 0 0 0 0	0 0 0 0 0 0 0 0 0 0 0 0	0 0 0 0 0 0 0 0 0 1 0 0	7
			Toxaphene			
4	1 1 0 1 0 0 0 1 0 0 0 1	0 0 0 0 0 0 0 0 0 1 0 0	1 1 0 1 1 0 0 0 0 0 0 0	0 0 0 0 0 1 0 0 0 1 0 0	0 0 0 0 0 0 1 1 0 0 0 0	
	0 0 0 0 0 0 0 0 0 0 0 0	0 1 1 0 0 0 0 0 0 0 1 0	0 0 0 0 0 0 0 0 0 0 0 1	0 0 0 0 0 0 0 0 0 0 0 0	0 0 0 0 0 0 0 0 0 0 0 0	

Table 9. Concl.

Plot no.	Grasshoppers caught in net after 36 uniform sweeps for each station: Station 1	Station 2	Station 3	Station 4	Station 5	Total
			Toxaphene (cont.)			
	0 0 0 0 0 0 0 0 0 0 0 0	0 0 0 0 0 0 0 0 0 0 0 0	0 0 0 0 0 0 0 0 0 0 0 0	0 0 0 0 0 0 0 0 0 0 0 0	0 0 0 0 0 0 0 0 0 0 0 0	18
			Aldrin			
5	0 0 0 0 0 0 0 0 0 0 0 0	0 0 0 0 0 0 0 0 0 0 0 0	0 0 0 0 0 0 0 0 0 0 0 0	0 0 0 0 0 0 0 0 0 0 0 0	0 0 0 0 0 0 0 0 0 0 0 0	
	0 0 0 0 0 0 0 0 0 0 0 0	0 0 0 0 0 0 0 0 0 0 0 0	0 0 0 0 0 0 0 0 0 0 0 0	0 0 0 0 0 0 0 0 0 0 0 0	0 0 0 0 0 0 0 0 0 0 0 0	
	0 0 0 0 0 0 0 0 0 0 0 0	0 0 0 0 0 0 0 0 0 0 0 0	0 0 0 1 0 0 0 0 0 0 0 0	0 0 0 0 0 0 0 0 0 0 0 0	0 0 0 0 0 0 0 0 1 0 0 0	2
			Chlordane			
6	0 0 0 0 0 0 0 0 0 1 0 0	0 0 0 0 0 0 0 0 0 0 0 0	0 0 0 0 0 0 0 0 1 0 0 0	0 0 0 0 0 0 0 0 0 1 0 0	0 0 0 0 0 0 0 1 0 0 0 0	
	0 0 0 0 0 0 0 0 0 0 0 0	0 0 0 0 0 0 0 0 0 0 0 0	0 0 0 0 0 0 0 0 0 0 0 0	1 1 0 0 0 0 0 0 0 0 0 0	0 0 0 1 0 1 1 1 1 0 1 0	
	0 0 0 0 1 0 0 0 0 0 1 0	0 0 0 0 0 0 1 0 0 1 0 0	1 1 0 0 0 0 0 0 0 0 0 0	0 0 0 0 0 0 0 0 0 1 0 0	0 0 0 1 1 0 0 0 0 0 0 0	21
			Check			
7	3 4 3 2 3 3 2 3 3 4 3 2	4 0 2 3 2 2 2 4 5 1 0 1	5 4 1 7 3 3 5 2 2 1 3 5	2 4 0 2 2 2 3 0 6 2 4 2	9 3 4 2 4 9 3 3 2 5 4 1	
	1 0 3 4 4 3 3 5 2 4 4 3	1 3 3 0 1 0 5 3 1 3 2 1	1 4 0 1 1 3 1 3 0 1 4 3	6 3 2 4 1 1 2 1 3 2 2 3	0 1 1 5 1 1 1 3 4 0 5 1	
	10 4 2 9 4 5 5 6 10 11 6 7	5 2 2 8 6 7 5 4 8 11 4 7	7 4 1 2 8 5 4 2 7 8 5 15	4 8 2 5 0 3 6 4 11 6 4 2	6 5 3 3 9 5 4 6 4 3 3 5	649

Table 10. Grasshopper populations on sprayed plots 7 days after treatment with three toxicants at the ManKan Airport as determined by the sweep net method.

Plot no.:	Grasshoppers caught in net after 36 uniform sweeps for each station					: Total
	Station 1	Station 2	Station 3	Station 4	Station 5	
			Chlordane			
1	0 0 1 0 0 0	0 0 0 0 0 0	1 0 4 0 1 0	0 1 0 0 0 0	1 1 0 0 0 0	
	1 0 0 0 0 1	1 0 0 0 0 0	0 3 0 1 0 0	0 0 0 0 1 1	1 0 0 1 0 0	
	1 0 0 0 0 0	0 0 0 0 2 0	0 1 1 1 0 1	0 1 0 1 0 1	1 0 0 1 0 0	
	1 0 0 0 0 0	1 2 0 0 1 0	0 1 0 1 0 0	0 1 0 0 0 0	1 0 1 0 0 0	
	0 1 1 0 0 0	0 0 0 0 0 0	0 0 0 0 0 0	0 0 0 0 0 0	0 0 0 0 0 0	
	0 0 1 0 0 0	0 0 0 1 1 1	0 0 1 0 1 0	0 1 0 1 0 1	1 1 0 0 0 0	56
			Toxaphene			
2	0 0 0 1 0 0	0 0 0 0 0 0	0 1 0 0 0 0	1 1 0 0 0 0	0 0 0 0 0 0	
	0 0 0 0 1 0	0 0 0 1 0 0	0 0 0 1 0 0	0 0 0 0 0 0	0 0 0 0 0 0	
			(newly hatched)			
	1 1 0 1 0 0	0 0 0 0 1 1	2 3 3 1 0 0	0 0 0 1 0 2	0 0 0 0 1 0	
	0 0 0 0 0 0	2 1 0 1 0 1	0 0 0 1 1 1	0 0 1 0 1 2	1 1 0 1 1 0	
	0 0 0 0 0 1	0 1 0 0 0 0	0 0 0 0 0 0	0 1 0 0 2 0	1 1 0 2 0 0	
	0 2 0 0 0 1	0 0 0 0 0 0	2 0 1 0 0 1	0 0 1 0 0 0	0 0 0 1 0 0	59
			Aldrin			
3	0 0 0 0 0 0	0 0 1 0 0 0	1 0 0 0 0 1	0 0 0 0 0 0	1 0 0 0 0 0	
	0 1 0 1 0 0	0 0 1 1 0 1	1 0 0 0 0 0	0 2 0 0 0 0	0 0 0 0 0 1	
	2 0 0 0 0 0	1 0 1 0 0 0	0 0 0 0 0 0	0 1 1 0 0 0	0 0 0 0 0 0	
	1 1 2 1 1 0	1 0 0 0 0 1	0 0 0 0 0 0	0 0 0 0 0 0	0 0 0 0 1 0	
	0 1 0 0 0 0	0 1 0 0 0 1	0 0 1 0 0 0	0 0 3 0 0 0	0 0 0 0 0 0	
	0 1 0 0 0 0	1 0 0 0 0 0	0 0 0 0 0 3	0 0 0 0 0 0	0 0 0 0 0 0	40
			Toxaphene			
4	1 0 0 0 0 0	0 0 0 0 0 0	0 0 0 0 1 0	0 0 0 0 0 0	0 0 1 0 0 0	
	1 0 0 0 0 0	0 0 0 0 0 0	0 1 1 0 0 0	0 0 0 0 0 0	0 0 0 0 0 0	
	0 1 1 0 2 0	0 1 0 0 0 0	0 0 0 0 0 0	0 0 0 0 2 1	1 0 1 0 0 0	
	0 1 0 1 0 1	0 0 0 0 0 0	0 0 0 1 0 0	0 0 0 1 0 0	1 0 0 1 1 1	

Table 10. Concl.

Plot no.	Grasshoppers caught in net after 36 uniform sweeps for each station: Station 1	Station 2	Station 3	Station 4	Station 5	Total
			Toxaphene (cont.) (grass)			
	0 0 0 0 0 0 1 0 1 0 0 0	1 0 0 0 0 2 0 1 0 0 0 0	2 0 0 2 0 0 0 1 1 1 0 1	0 2 2 2 1 1 3 0 1 2 1 1	1 0 0 0 2 1 1 0 3 2 0 0	65
			Aldrin			
5	1 0 0 0 2 0 0 0 0 0 1 0	0 0 0 0 0 0 0 0 0 0 0 0	0 0 0 0 0 0 0 0 0 0 0 0	0 0 0 1 0 0 0 0 0 0 0 2	0 0 0 0 0 0 0 0 0 0 0 0	
	0 0 0 0 0 0 0 0 0 0 0 0	0 0 0 0 0 0 0 0 0 0 0 0	0 0 0 0 0 1 0 0 0 0 0 0	1 0 0 0 1 0 0 0 0 0 0 0	0 0 0 0 0 0 0 0 0 0 0 0	
	0 0 0 0 0 0 0 1 1 0 0 0	0 0 0 1 0 0 0 0 0 0 1 3	0 0 0 2 0 0 0 0 0 0 0 0	0 0 0 0 0 0 1 0 1 0 0 0	0 0 0 0 1 0 0 0 0 1 0 0	20
			Chlordane			
6	0 0 0 0 0 0 0 0 1 0 0 0	0 0 0 0 0 0 0 0 0 0 0 0	0 0 0 0 0 0 0 0 1 0 0 0	0 0 0 0 0 0 0 0 0 1 0 0	0 1 0 0 0 0 0 0 0 0 0 0	
	0 0 0 0 0 0 0 0 0 0 0 0	0 0 0 0 0 0 0 0 0 0 0 0	2 0 0 1 0 0 1 0 0 0 0 0	0 0 0 0 0 0 2 2 1 0 1 0	0 0 0 0 0 0 0 1 0 0 0 0	
	0 0 1 0 0 0 0 0 1 1 0 1	0 0 1 1 0 0 1 0 0 0 0 0	1 0 0 0 0 0 0 1 0 0 1 0	0 0 0 0 0 1 0 0 1 0 0 1	0 0 2 0 1 0 0 1 0 0 0 0	32
			Check			
7	0 0 0 0 0 0 0 0 0 1 1 1	1 0 1 2 2 0 2 2 2 0 0 0	2 0 0 1 1 0 0 0 0 2 1 1	2 0 1 0 3 0 3 1 0 0 1 0	2 1 0 1 2 1 3 3 3 0 1 1	
	6 1 3 5 4 3 3 2 1 3 4 1	2 0 1 1 1 0 1 2 3 4 2 4	0 1 4 0 3 1 0 1 4 0 3 1	0 6 2 2 2 1 1 5 6 1 2 1	0 1 3 1 0 1 2 4 4 1 0 0	
	3 2 3 1 2 2 5 1 4 0 1 0	0 2 1 3 0 0 1 0 1 1 0 3	2 1 0 3 0 1 2 2 2 3 4 7	2 1 1 0 0 1 1 4 2 1 5 1	2 1 3 2 0 2 1 0 2 1 6 1	273

Table 11 shows that chlordane at one pound per acre effected 87 per cent reduction in population 24 hours after application; at 72 hours, 96 per cent; and at 7 days, an 83 per cent reduction was found.

Toxaphene at 1.76 pounds per acre showed a 70 per cent reduction 24 hours after application; at 72 hours, a 98 per cent reduction; and 7 days, a 72 per cent reduction was effected.

Aldrin at 0.25 pounds per acre effected at 24 hours a 97.5 per cent reduction; at 72 hours, a 98.5 per cent reduction; and at 7 days after application, an 88.5 per cent reduction.

Figure 21 shows the comparative rate of reduction of grasshoppers by the sprays over a seven-day period.

Table 11. Effectiveness of three insecticides used in sprays against grasshoppers in alfalfa at ManKan Airport, Pottawatomie County, Kansas, from June 30 to July 7, 1949.

Materials	Lbs. of actual insecticide per acre	Per cent reduction of grasshoppers*		
		24 hours	72 hours	7 days
Chlordane	1.0	87	96	83
Toxaphene	1.76	70	98	72
Aldrin	0.25	97.5	98.5	88.5

*Based in comparison with the check plot.

Extent of Webworm Damage Observed on Plots Sprayed for Grasshoppers. The average degree of infestation is shown as follows:

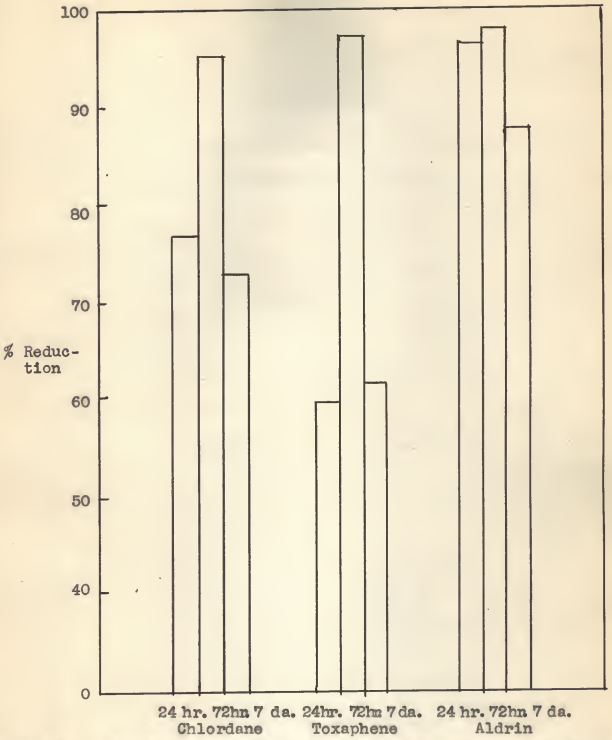


Fig. 21. Percentage and comparative rate of reduction of grasshoppers in alfalfa at 24 hours, 72 hours, and 7 days by toxaphene, chlordane, and aldrin used as sprays.

Material used	Lbs. actual toxicant per acre	Type injury	Av. degree of inf.
Chlordane	1.0	Severe	3.7
Toxaphene	1.76	Little	.82
Aldrin	0.25	Severe	3.5
Check	____	Severe	3.8

SUMMARY AND CONCLUSIONS

Baiting - ManKan Airport

Aldrin, at the rate of 0.0124 pounds per acre in bran baits, showed a consistently higher rate of grasshopper reduction than any of the other materials tested. When applied to alfalfa in the early morning at a temperature of 77° F., aldrin at the same dosage as applied to alfalfa in the afternoon at a temperature of 89° F., showed a high reduction of grasshopper population but not as high as that of the material applied in the morning.

White arsenic, in bran baits, applied to alfalfa at the rate of 6.4 ounces per acre in the morning at a temperature of 78° F., showed a 7 per cent reduction of the population at 24 hours but, at 72 hours after application, only a slight increase in reduction was evident, and in 7 days a 31 per cent reduction was determined. White arsenic in poison bran baits applied to alfalfa in the same dosage as above, in the afternoon, at a temperature of 89° F. gave similar poor results.

Chlordane at the rate of 0.05 pounds per acre applied to alfalfa in the morning at a temperature of 77° F. showed a poor reduction in grasshopper population at 24 hours. The number of

grasshoppers on this plot decreased at 72 hours and 7 days. Chlordane made a poor showing at the dosage applied in the morning. Chlordane, applied in the afternoon at a temperature of 89° F. at the same dosage as the morning treatment, showed better results. The reduction in grasshopper population was consistent during the three samplings of this plot.

Toxaphene, applied to alfalfa in bran baits at the rate of 0.1 pounds per acre and in the morning at the temperature of 74° F., was partially effective against grasshoppers at this dosage, the highest reduction being 67 per cent at 7 days. Toxaphene, at the above dosage applied to alfalfa in the afternoon at a temperature of 89° F., showed a higher reduction in grasshoppers at 72 hours after treatment.

The four materials used in baits, applied both in the morning and in the afternoon, are rated as follows in their average effectiveness against grasshoppers for one week:

Material	When applied	Temperature, °F.
Aldrin	A. M.	77°
Aldrin	P. M.	89°
Chlordane	P. M.	89°
Toxaphene	P. M.	89°
Toxaphene	A. M.	74°
Chlordane	A. M.	74°
White arsenic	P. M.	89°
White arsenic	A. M.	78°

Baiting - Geary County

Aldrin at 0.012 pounds per acre showed very good results in the control of the two-lined grasshopper, Melanoplus bivittatus Say.

Spraying - ManKan Airport

Grasshoppers. Aldrin at the rate of 0.25 pounds per acre showed a higher initial and more consistent reduction of the grasshopper population than any of the materials used. Chlordane at the rate of 1.0 pounds per acre was next best of the materials. At this dosage, chlordane effected a reduction as high as 96 per cent. Toxaphene performed very well at 72 hours after application, but still was not as effective as the other materials against grasshoppers.

Webworms. Of the three materials, chlordane at 1.0 pounds per acre, toxaphene at 1.76 pounds per acre, and aldrin at 0.25 pounds per acre, applied to alfalfa for the control of grasshoppers, toxaphene showed the most promising results.

Role of Poison Baits in Modern Grasshopper Control

With the advent of the chlorinated hydrocarbon sprays, it has appeared to certain investigators that poisoned bran baits for grasshopper control have become obsolete. This reasoning is not absolutely correct, as has been shown in these experiments. Poison bran baits still have their place. It has been demonstrated that poison baits have a good effectiveness against grasshoppers

in newly cut alfalfa fields.

For the smaller farmer who has little capital to invest in expensive spraying equipment, poison bran baits using some of the recommended new insecticides are his answer to the grasshopper control problem.

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